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leating Plant Options Economic nalysis System (HPECON) Jser's Manual and Technical Reference

alph Moshage
obert Januzik
obert Flanigan
'illiam Scherer

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13. ABSTRACT (Maximum 200 words)

HPECON is a PC-based software system that estimates the economic feasibility of alternative heating plant technologies. This system requires minimum input and offers its users insight into the justifiability of more costly analyses.

HPECON compares technologies in terms of their capital costs, annual operating costs, and life-cycle costs. The system considers coal, oil, natural gas, and wood technologies for plant sizes from 5 to 150 MBtu/hr.

The system is divided into four primary programs: HPDATA, HEATLOAD, HPCALC, and LCCID. Also included are two other programs that offer system administrator functions to authorized individuals: HPCREATE and HLCREATE. The HPECON system includes six floppy diskettes and this manual. The six disks contain the software necessary to install and run HPECON on either a two-floppy or hard-disk system.

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FOREWORD

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This research was performed by the Energy and Utility Systems Division of the U.S. Army Construction Engineering Research Laboratory (USACERL-ES). The USACERL Principal Investigator was Ralph Moshage. Special acknowledgement is given to ES personnel Bonnie Bielfeldt and Samuel McCammon for their work in developing HPECON. Arthur D. Little, Inc., is also recognized for its work on developing cost equations and for preliminary work on the computer models contained in this manual. Dr. G.R. Williamson is Chief, USACERL-ES. The USACERL Technical Editor was William J. Wolfe, Information Management Office.

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HEATING PLANT OPTIONS ECONOMIC ANALYSIS SYSTEM (HPECON) USER'S MANUAL AND TECHNICAL REFERENCE

I HPECON

1. INTRODUCTION

The U.S. Army must choose heating plant technologies to suit the location and circumstances of individual facilities. The Heating Plant Options Economic Analysis System (HPECON) is a personal computer-based system, created to help design engineers compare the economic benefits of alternative heating plant technologies. HPECON compares coal, oil, natural gas, and wood technologies, and can also accommodate other liquid fuels. The system compares technologies by their capital costs, annual operating costs, and life-cycle costs, and is designed for heating plants with capacities between 5 and 150 MBtu/hr.

HPECON calculates capital and operating costs based on conditions in the continental United States. When used outside the United States HPECON may not accurately estimate costs, however the results should reflect relative rankings of competing technologies.

HPECON contains four primary programs: (1) HPDATA, (2) HEATLOAD, (3) HPCALC, and (4) LCCID[1]. Also included are two other programs that offer system administrator functions to authorized individuals: HPCREATE and HLCREATE. Figure I-1 shows the general flow of information through HPECON.

HPECON software and documentation are available through the National Technical Information Center, 5285 Port Royal Road, Springfield, VA, 22161.

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[1] Linda Lawrie, *Development and Use of the Life Cycle Cost in Design Computer Program*, Technical Report E 85/07/ADA162522 (U.S. Army Construction Engineering Research Laboratory [USACERL], November 1985).

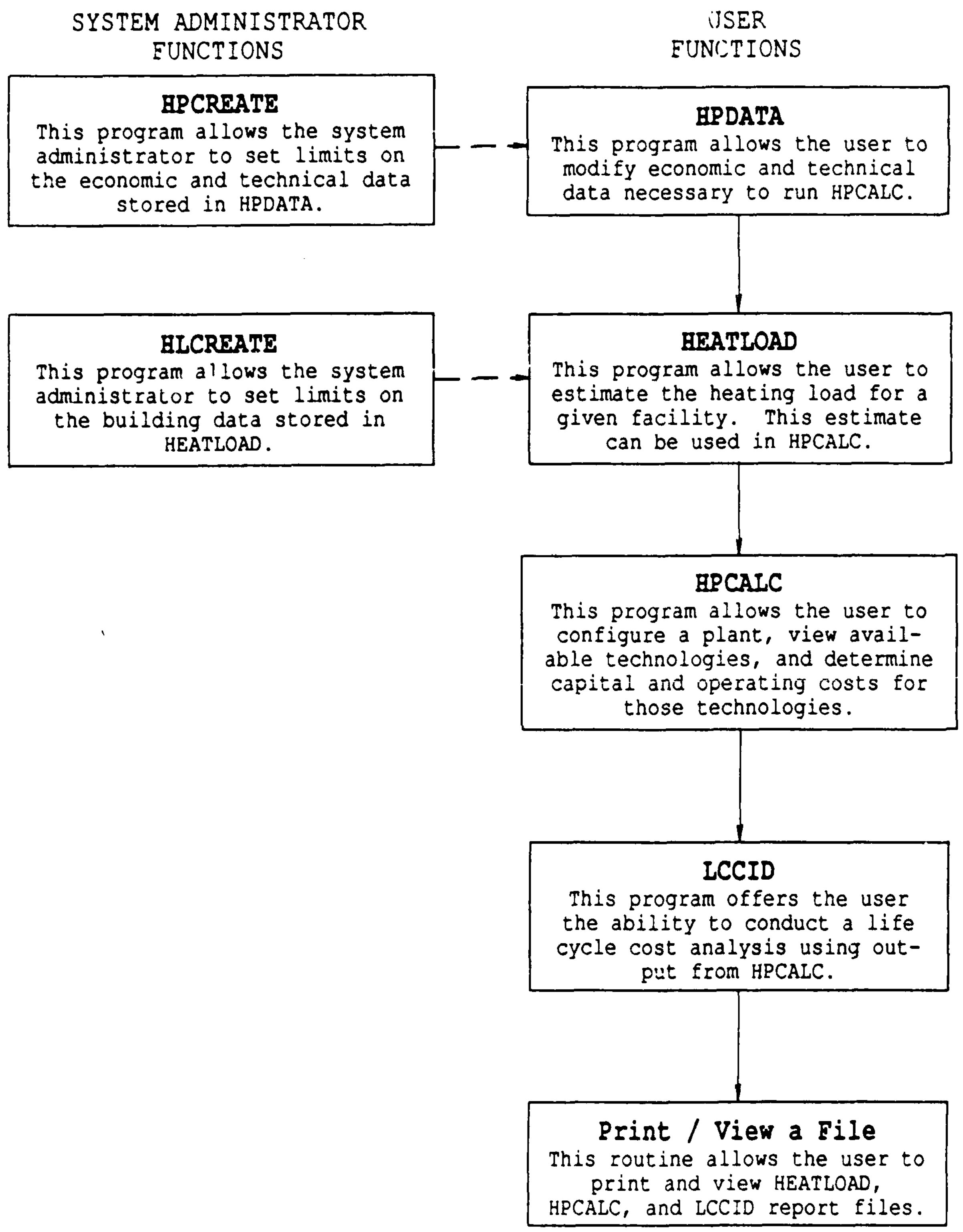

Figure I-1. HPECON system flow diagram.

2. SYSTEM OVERVIEW

2.1 Introduction

Heating Plant Options Economic Analysis System (HPECON) is a software package that performs an economic analysis for alternative heating plant options. The system estimates capital equipment costs and annual operating costs for each available fuel/technology combination and then evaluates these costs to obtain an overall life cycle cost for that configuration. The complete package includes an HPECON User's Manual/Technical Reference, an LCCID User's Manual, and six floppy disks, containing all programs and data files.

The programs are designed to run on an IBM-PC compatible computer with either two floppy disk drives or a single floppy drive and a fixed disk.

2.2 Economic Data

HPECON includes a complete set of technical and economic data. In order to customize this data for a particular installation, the user must run HPDATA (a program run from within HPECON). An HPDATA data file contains fuel data, technology data, capital cost data, operating cost data, miscellaneous cost data, capital cost indices, and operating cost indices. Although this data is simple to modify, HPDATA also provides a measure of security. The value for each parameter found in HPDATA (except for those stored in the Capital and Operating Cost Indices data tables) must fall within a predetermined range. Minimum and maximum values are assigned to each variable by the system administrator to define a range of acceptable values. The system administrator may also specify default values for each parameter. These features serve to protect the integrity of HPECON's results without limiting the system's flexibility.

It should be noted that all cost data are stored in U.S. dollars and reflect U.S. prices. For use in Europe, results based on this data will likely be valid for comparing alternative technologies; however specific costs may need to be adjusted to reflect current costs in Europe.

2.3 Determination of Facility Heating Load Profile

HPECON includes a program named HEATLOAD, which estimates the expected heating loads for a given facility. HEATLOAD uses building data and climate region data specific to the facility to calculate a maximum design load, a minimum design load, and an average design load. These estimates can be used in HPCALC to determine plant size and configuration.

2.4 Capital Equipment and Operating Cost Analysis

HPECON calculates capital equipment costs and operating costs within HPCALC. The capital equipment cost calculations estimate costs for new boilers, balance of plant fixtures, SO_2 air pollution control equipment, particulate air pollution control equipment, a retrofit of the current facility, contingencies, and engineering, design, and construction management. The operating cost calculations estimate annual costs for operational and supervisory labor, nonlabor operations and maintenance, fuel, power, SO_2 air pollution control, particulate air pollution control, waste disposal, water, taxes, and insurance.

Several of these costs are estimated using an order of magnitude cost equation. For a thorough explanation of this costing technique, refer to USACERL Interim Report E-85/04, *Fuel-Burning Technology Alternatives for the Army.*[2]

Before costs are calculated, the user is prompted to configure the plant. The user must specify steam or hot water as the energy delivery system, decide the number of boilers to be operated and their corresponding backup configuration, select an SO_2 air pollution control technology (none, dry scrubber with baghouse, or user-defined), and select a particulate air pollution control technology (none, baghouse, electro-static precipitator, or user-defined). In addition, the user is asked to supply information such as the date of the study, the expected date for the start of construction, and whether or not the project is a retrofit.

Much of the cost data stored in HPDATA is recorded in 1987 dollars. Therefore, all such cost data is adjusted to reflect current prices as of the date of study.

2.5 Life Cycle Cost Analysis

HPECON accommodates the transfer of capital and operating cost data (generated by HPCALC) to a life cycle cost analysis program named Life Cycle Cost in Design (LCCID). LCCID can be run from HPECON or as a stand-alone program.

[2] E. Thomas Pierce, *Fuel-Burning Technology Alternatives for the Army*, IR E-85/04/ ADA151527 (USACERL, January 1985).

II HPECON USER'S MANUAL

1. BEFORE YOU BEGIN

1.1 Hardware Requirements

Table II-1 lists the hardware necessary to operate HPECON.

Table II-1
Hardware Requirements

Equipment	Description
MS-DOS computer	IBM PC, XT, AT, or compatible
Minimum memory	640K
Disk drives	• Two 5 1/4 in. disk drives, or • One 5 1/4 in. disk drive and one fixed disk (For a fixed disk application, approximately 2 megabytes of disk space are needed.)
DOS	DOS 3.0 or later
HPECON disks	DISK 1 — HPECON-Program DISK 2 — HPECON-System DISK 3 — HEATLOAD-Program DISK 4 — HPECON-Sample Data DISK 5 — LCCID-1 DISK 6 — LCCID-2
Other disks	Blank, formatted disks for use as backup or data disks
Printer	Needed for printing generated reports

1.2 About the Program

HPECON is a computer program written in Borland International's Turbo Pascal Version 5.5.[3] The programs are compiled to run without a math co-processor.

The entire system is menu-driven to facilitate a friendly user interface.

[3] Borland International, Inc., 1800-T Green Hills Rd., Scotts Valley, CA 95066.

1.3 Program Basics

Most of the screens in HPECON are split into two sections: The top portion of the screen prompts the user to make menu selections or to enter data. The bottom portion of the screen displays a help window to explain the top portion.

To return to the HPECON Main Menu from anywhere in the programs, simultaneously press <Ctrl> and <Break>.

When making a menu selection, the user has two choices:

1. To use the arrow keys to highlight the desired selection, then press <Enter>.
2. To type the number or letter corresponding to the desired menu selection. Do <u>not</u> press <Enter> when making a menu selection in this way.

When choosing a filename from within HPECON, use the arrow keys to highlight the desired selection and then press <Enter>. To change directories or drives, highlight the appropriate directory or drive name and press <Enter>.

When viewing a report or data file, use the arrow keys and the <Pg Up> and <Pg Dn> keys to scroll text.

While entering data, the user should note the following:

1. Values must be entered in correct units. (Units are noted beside each data cell.)
2. In the program HPDATA, all costs must be entered in U.S. dollars.
3. For entering percentages, do not precede the number by a decimal point, and do not include a percent sign (%). (Example: 25% is entered as 25.)
4. When multiple data entries are required within a single screen, the user may move the cursor between the data cells using the arrow keys or the <Enter> key.
5. To display the range of acceptable values for a given parameter, the user should type "?" in the data cell and then press <Enter>.

6. If the user enters invalid data into a cell, the message "Value out of range" is displayed and the user is prompted to enter a new value.

7. When the screen shows correct values in each cell, the user should press <F10> to proceed to the next screen.

1.4 Installing HPECON

The HPECON programs are supplied on 6 disks: HPECON-Program, HPECON-System, HEATLOAD-Program, HPECON-Sample Data, LCCID-1, and LCCID-2. (Be sure to make backup copies of these disks.)

1.4.1 Floppy disk installation

The HPECON system, as received by the user, is configured to run from two floppy disks. However, the user must copy the DOS file COMMAND.COM to the HPECON-Program and LCCID-1 Disks (disks 1 and 5, respectively) to ensure proper operation of the programs.

Section 1.5 (below) explains the procedure for creating a new data disk.

1.4.2 Fixed disk installation

For fixed disk applications, HPECON has an installation program that allows the user to place the program files on a particular drive and under particular directories. (Default directory names are provided.) Indicated directories are created if they do not already exist. (NOTE: The HPECON system, including LCCID, requires approximately 2 megabytes of disk space.)

The batch files HPECON.BAT and LCCID.BAT are written to the root directory of the selected drive.

To install HPECON on a fixed disk, put the HPECON-System Disk (disk 2) in drive A and type "HPSETUP" at the A:\> prompt. The HPSETUP program provides step-by-step installation instructions.

1.5 Creating a New Data Disk

NOTE: This procedure is only necessary when HPECON is installed on a two-floppy system.

To create a new DATA Disk (similar to disk 4), put the HPECON-System Disk (disk 2) in drive A and put a blank, formatted disk in drive B, then type "HPSETUP" at the A:\> prompt. (The user is alerted when necessary to change disks.)

2. STARTING HPECON

2.1 Floppy Disk Operation

For floppy disk operation, all disks use drive A except for the data disks, which use drive B. Data disks include the HPECON-Sample Data Disk provided with the system (disk 4) and any user-created data disks.

To run HPECON, put the HPECON-Program Disk (disk 1) in drive A and a data disk in drive B. Type "HPECON" at the A:\> prompt. The user is alerted when it becomes necessary to change the disk in drive A.

2.2 Fixed Disk Operation

To run HPECON, type "HPECON" in the root directory of the drive where the programs are installed.

3. USING HPECON

The program named HPECON consists of a single menu from which the user may run one of the following programs:

1. **HPDATA** allows the user to create or modify an installation-specific HPCALC input data file (extension ".CDA").

2. **HEATLOAD** creates and modifies data files which may be used as input for HPCALC. HEATLOAD evaluates facility energy demands based on climate region and building space. (HEATLOAD report files have the extension ".HPT", while HPCALC input files have the extension ".HDA".)

3. **HPCALC** performs an economic analysis of various fuel/technology combinations. The report generated by HPCALC can be viewed and printed, and the results can be saved as input data for LCCID. (HPCALC report files have the extension ".EPT", while LCCID input files have the extension ".LCI".)

4. **LCCID** performs a life cycle cost analysis of various heating plant configurations. The report generated by LCCID can be viewed and printed using option 5 of HPECON's Main Menu. (LCCID report files have the extension ".RPT".)

5. **Print/View a File** allows the user to view or print HEATLOAD, HPCALC, or LCCID report files.

On HPECON's Main Menu screen, use the arrow keys to highlight the desired selection. Press <Enter> to make the choice. (Selections can also be made by typing the number of the choice.)

<Esc> exits the HPECON Main Menu.

To abort the current program and return to the HPECON Main Menu, simultaneously press <Ctrl> and <Break>.

NOTE: When attempting to print a report or data file, the printer must be connected, otherwise the current program is terminated and the user is returned to the HPECON Main Menu.

3.1 HPDATA

To run HPDATA, choose option 1 from the HPECON Main Menu.

HPDATA allows the user to modify, create, view, and print HPCALC input files (extension ".CDA").

Each HPDATA file is composed of the following data tables:*

Table 1 — fuels
Table 2 — technology types
Table 3 — capital costs
Table 4 — O&M costs
Table 5 — miscellaneous parameters
Table 6 — capital cost indices
Table 7 — O&M cost indices.

Each data record stored in tables 1 through 5 lists a current, default, minimum, and maximum value. HPCALC uses the current values for its analysis.

As received, the HPECON system includes a data file named CERLDATA.CDA. Because the data in this file may not reflect the local conditions for a given facility, the user may choose to modify this file. Alternatively, the user may choose to use CERLDATA.CDA as a prototype to create a new data file.

To create a new data file, the user must load an existing file and save it under a new name. This newly created file may then be modified.

When creating or modifying a file, the user may accept current values or enter new ones. Each user-entered value must comply with the maximum and minimum acceptable values indicated on the screen. In cases where the maximum and minimum values are equal, the data cannot be modified.

For information about changing the maximum, minimum, and default values, refer to section II-4.1, HPCREATE.

Section II-3.1.1 contains a flow diagram of the HPDATA program.

Sections II-3.1.2 through II-3.1.8 contain sample data tables for HPDATA.

* Note: All cost data must be recorded in U.S. dollars.

3.1.1 HPDATA program flow diagram

Figure II-1 shows the flow of the HPDATA program.

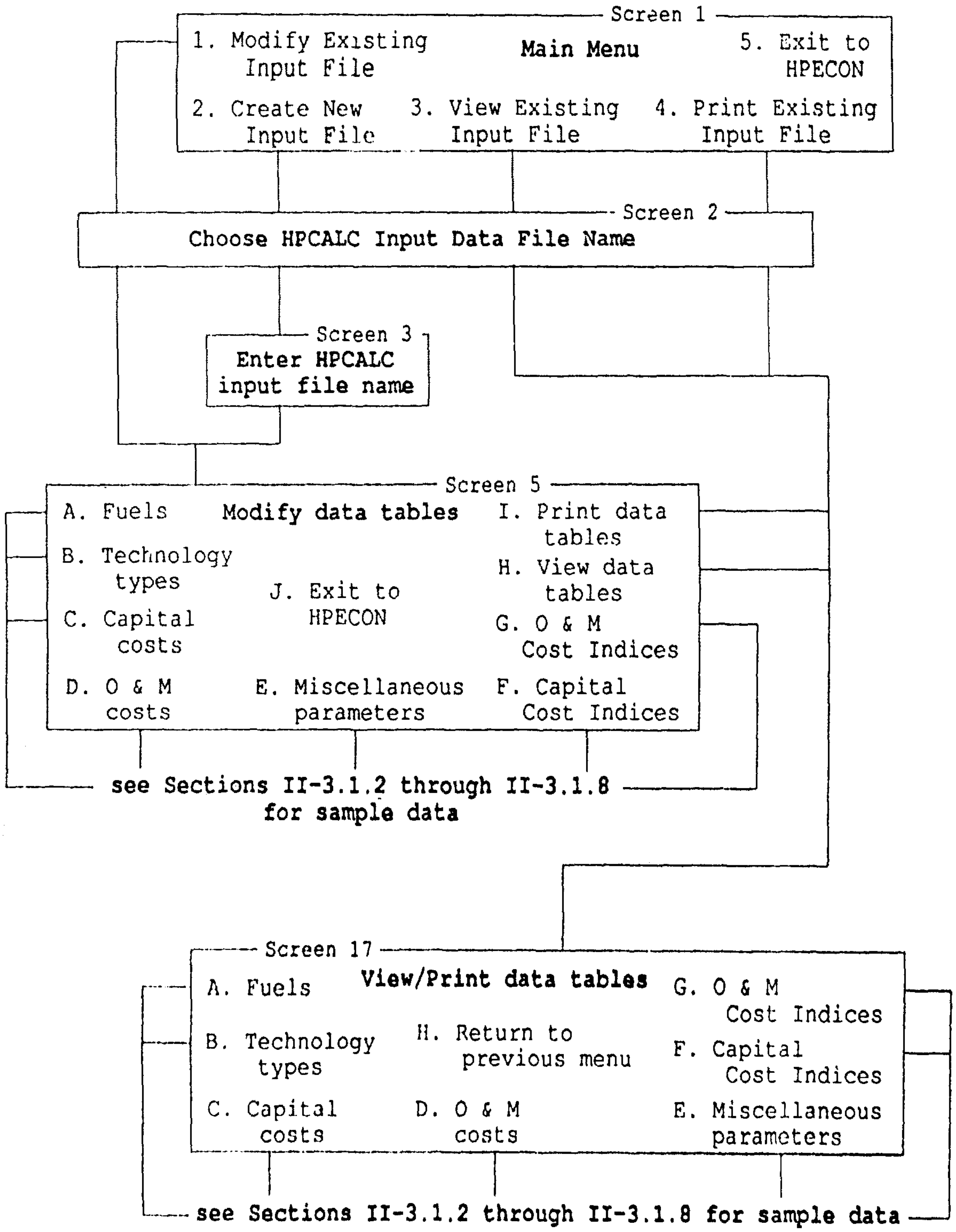

Figure II-1. HPDATA program flow diagram.

3.1.2 Sample fuel data

Table II-2 lists the available fuel types.

Table II-2
Fuel Types

Fuel Type	Fuel Type
Type 1 - No 2 Oil	Type 4 - Coal
Type 2 - No 6 Oil	Type 5 - Wood
Type 3 - Natural Gas	Type 6 - Option 1

Figure II-2 illustrates the information stored for coal.

Values for file: CERLDATA.CDA (Fuel Data)

Fuel Type		Parameter Units	Current	Default	Minimum	Maximum
Coal	- 4	HHV......Btu/unit	13560.000	13560.000	8000.000	15000.000
Coal	- 4	Conversion Factor	2000.000	2000.000	2000.000	2000.000
Coal	- 4	Sulfur........ %	1.600	1.600	0.000	6.000
Coal	- 4	Ash........... %	7.800	7.800	5.000	15.000
Coal	- 4	Moisture...... %	2.400	2.400	0.000	15.000

Figure II-2. Sample fuel data for coal.

The *HHV* (Higher Heating Value) and the *Conversion Factor* are recorded in different units for each fuel type. Table II-3 lists these units.

Table II-3
Fuel Type Units

Fuel Type	HHV	Conversion
Type 1 - No 2 Oil	Btu/lb	lb/gal
Type 2 - No 6 Oil	Btu/lb	lb/gal
Type 3 - Nat Gas	Btu/cf	cf/kscf
Type 4 - Coal	Btu/lb	lb/ton
Type 5 - Wood	Btu/lb	lb/ton
Type 6 - Option 1*	Btu/lb	lb/gal

*Note: *Option 1* must be a liquid fuel having the units listed.

3.1.3 Sample technology type data

Table II-4 lists the available technology types.*

Table II-4
Technology Types

Technology Type		Technology Type		Technology Type	
Coal-Sto	ft:s	Nat Gas	ft:w	2Oil/Gas	ft:w
Coal-Sto	wt:s	Nat Gas	ft:s	2Oil/Gas	ft:s
No 6 Oil	ft:s	Nat Gas	wt:s	2Oil/Gas	wt:s
No 6 Oil	wt:s	Wood	wt:s	Other 1	??:?
No 2 Oil	ft:w	Gas/2Oil	ft:w	Other 2	??:?
No 2 Oil	ft:s	Gas/2Oil	ft:s	Other 3	??:?
No 2 Oil	wt:s	Gas/2Oil	wt:s		

Where: ft = fire-tube s = steam
wt = water-tube w = hot water
?? = not defined ? = not defined

Figure II-3 illustrates the technology related information stored for each technology type.

Values for file: CERLDATA.CDA (Technology Types)

Tech Type	Parameter	Units	Current	Default	Minimum	Maximum
Coal-Sto wt:s	Size ....MBtu/hr.		30.000	30.000	10.000	50.000
Coal-Sto wt:s	Fuel Type.. (#)		4.000	4.000	4.000	4.000
Coal-Sto wt:s	Boiler Efficiency..%		75.000	75.000	70.000	80.000
Coal-Sto wt:s	Parasitic Power....%		0.600	0.600	0.000	10.000
Coal-Sto wt:s	Not Used............		0.000	0.000	0.000	0.000
Coal-Sto wt:s	Asset Life**...yrs..		25.000	25.000	25.000	25.000
Coal-Sto wt:s	Forced Outage Rate.%		14.400	14.400	0.000	20.000
Coal-Sto wt:s	Planned Outage Rate%		3.800	3.800	2.000	5.000
Coal-Sto wt:s	Op Labor - men/shift		2.000	2.000	1.000	5.000
Coal-Sto wt:s	Super Labor- men/day		1.000	1.000	0.000	5.000
Coal-Sto wt:s	Maint cost-% CE cost		2.500	2.500	0.000	5.000
Coal-Sto wt:s	Unit mult for op lab		0.750	0.750	0.000	1.000

Figure II-3. Sample technology data for Coal-Sto wt:s.

* Note: For dual fuel technologies, the first fuel listed is the primary fuel.

** Note: According to the Federal Standard (FEDS), the economic life expectancy for a project (Asset Life) should not exceed 25 years.

3.1.4 Sample capital cost data

Figure II-4 illustrates the capital cost information stored for each technology type. (Table II-4 contains a listing of the technology types.)

Values for file: CERLDATA.CDA (Capital Cost Data)

Tech Type	Parameter	Units	Current	Default	Minimum	Maximum
Coal-Sto wt:s	Equip Cost.a (coef)		121.290	121.290	121.290	1[illegible]290
Coal-Sto wt:s	Equip Cost.b (exp).		0.590	0.590	0.590	0.590
Coal-Sto wt:s	BOP...% equip cost.		25.000	25.000	25.000	25.000
Coal-Sto wt:s	Not Used...........		0.000	0.000	0.000	0.000
Coal-Sto wt:s	APC-Baghouse coef..		26844.000	26844.000	26844.000	26844.000
Coal-Sto wt:s	APC-SO2 cost.coef..		96120.000	96120.000	96120.000	96120.000
Coal-Sto wt:s	APC-ESP.cost.coef..		62841.000	62841.000	62841.000	62841.000
Coal-Sto wt:s	Retrofit % (of BOP)		75.000	75.000	0.000	200.000

Figure II-4. Sample capital cost data for Coal-Sto wt:s.

3.1.5 Sample O&M cost data

Figure II-5 illustrates the operations and maintenance cost information stored for each technology type. (Table II-4 contains a listing of the technology types.)

Values for file: CERLDATA.CDA (O&M Cost Data)

Commodity Units	Parameter	Current	Default	Minimum	Maximum
Not Used...........	Unit Cost	0.00	0.00	0.00	0.00
	RR of Esca	0.00	0.00	0.00	0.00
Water Treat.$/1000 g	Unit Cost	3.00	3.00	0.00	5.00
	RR of Esca	3.00	3.00	0.00	10.00
Oper -Labor*.$/manhr	Unit Cost	18.51	18.51	15.00	25.00
	RR of Esca	3.00	3.00	0.00	10.00
Super-Labor*.$/manhr	Unit Cost	24.38	24.38	20.00	40.00
	RR of Esca	3.00	3.00	0.00	10.00
Fuel: #2Oil**..$/gal	Unit Cost	0.61	0.61	0.25	5.00
	RR of Esca	3.00	3.00	0.00	10.00
Fuel: #6Oil**..$/gal	Unit Cost	0.43	0.43	0.25	5.00
	RR of Esca	3.00	3.00	0.00	10.00
Fuel: NatG**..$/kscf	Unit Cost	2.50	2.50	0.50	10.00
	RR of Esca	3.00	3.00	0.00	10.00
Fuel: Coal**..$/ton.	Unit Cost	50.00	50.00	35.00	125.00
	RR of Esca	3.00	3.00	0.00	10.00
Fuel: Wood**..$/ton.	Unit Cost	28.00	28.00	15.00	45.00
	RR of Esca	3.00	3.00	0.00	10.00
Fuel: Opt 1**..$/gal	Unit Cost	0.38	0.38	0.25	5.00
	RR of Esca	3.00	3.00	0.00	10.00
Purch Elec..$/kWh...	Unit Cost	0.08	0.08	0.01	0.20
	RR of Esca	3.00	3.00	0.00	10.00
Waste Disp..$/ton...	Unit Cost	10.00	10.00	0.00	50.00
	RR of Esca	3.00	3.00	0.00	10.00
Lime (Dry)..$/ton...	Unit Cost	60.00	60.00	25.00	200.00
	RR of Esca	3.00	3.00	0.00	10.00
Baghouse fixed exp..	scalar	0.70	0.70	0.70	0.70
Baghouse fixed coef.	$/MBtu/hr	4476.00	4476.00	4476.00	4476.00
Baghouse varia coef.	$/MBtu/yr	0.34	0.34	0.34	0.34
ESP fixed exp.......	scalar	0.70	0.70	0.70	0.70
ESP fixed coef......	$/MBtu/hr	4476.00	4476.00	4476.00	4476.00
ESP varia coef......	$/MBtu/yr	0.17	0.17	0.17	0.17
Dry Scrub fixed exp.	scalar	0.70	0.70	0.70	0.70
Dry Scrub fixed coef	$/MBtu/hr	6715.00	6715.00	6715.00	6715.00
Dry Scrub varia coef	$/MBtu/yr	0.68	0.68	0.68	0.68

Figure II-5. Sample O&M cost data for Coal-Sto wt:s.

* Note: The unit costs for Operational Labor and Supervisory Labor include all overheads.

** Note: Fuel costs include the cost of delivery.

3.1.6 Sample miscellaneous parameters data

Figure II-6 illustrates the miscellaneous parameters stored in the database. These values are the same for each fuel type and for each technology type.

Values for file: CERLDATA.CDA (Misc Param Data)

Parameter Units	Current	Default	Minimum	Maximum
Not Used...............	0.00	0.00	0.00	0.00
Engr,Des,Const Mgmt...%	25.00	25.00	0.00	40.00
Cap Cost Contingency..%	15.00	15.00	0.00	50.00
Not Used...............	0.00	0.00	0.00	0.00
Taxes and Insurance...%	0.00	0.00	0.00	10.00
Yr of annual cost data.	1990.00	1990.00	1980.00	2020.00
Inflation ....%	3.00	3.00	0.00	50.00
Turn Down Ratio : Coal	3.00	3.00	1.00	10.00
Turn Down Ratio : Oil	4.00	4.00	1.00	10.00
Turn Down Ratio : Gas	5.00	5.00	1.00	10.00
Turn Down Ratio : Wood	3.00	3.00	1.00	10.00
Stoichiometric Ratio...	2.00	2.00	1.00	3.00

Figure II-6. Sample miscellaneous parameters data.

3.1.7 Sample capital cost indices

Figure II-7 contains capital cost indices.[4] These values are the same for each fuel type and for each technology type.

Values for file: CERLDATA.CDA (Capital Cost Indices)

Reference year = 1987 Cost index for this year = 323.80

Year	Current Index	Calculated Rate %
1987	323.80	N/A
1988	342.52	5.78
1989	355.43	3.77
1990	366.09	3.00
1991	377.07	3.00
1992	388.39	3.00
1993	400.04	3.00
1994	412.04	3.00
1995	424.40	3.00
1996	437.13	3.00
1997	450.25	3.00
1998	463.75	3.00
1999	477.67	3.00
2000	492.00	3.00
2001	506.76	3.00
2002	521.96	3.00
2003	537.62	3.00
2004	553.75	3.00
2005	570.36	3.00
2006	587.47	3.00

Figure II-7. Sample capital cost indices.

[4] The capital cost indices are the "annual indices" as obtained from *Chemical Engineering Magazine's* CE PLANT COST INDEX.

3.1.8 Sample O&M cost indices

Figure II-8 contains operations and maintenance cost indices.[5] These values are the same for each fuel type and for each technology type.

Values for file: CERLDATA.CDA (O&M Cost Indices)

Reference year = 1987 Cost index for this year = 813.60

Year	Current Index	Calculated Rate %
1987	813.60	N/A
1988	852.00	4.72
1989	895.11	5.06
1990	921.97	3.00
1991	949.63	3.00
1992	978.11	3.00
1993	1007.46	3.00
1994	1037.68	3.00
1995	1068.81	3.00
1996	1100.88	3.00
1997	1133.90	3.00
1998	1167.92	3.00
1999	1202.96	3.00
2000	1239.05	3.00
2001	1276.22	3.00
2002	1314.50	3.00
2003	1353.94	3.00
2004	1394.56	3.00
2005	1436.39	3.00
2006	1479.49	3.00

Figure II-8. Sample O&M cost indices.

[5] The operations and maintenance cost indices are the "annual indices" as obtained from *Chemical Engineering Magazine's* MARSHALL & SWIFT EQUIPMENT COST INDEX.

3.2 HEATLOAD

To run HEATLOAD, choose option 2 from the HPECON Main Menu.

HEATLOAD allows the user to estimate yearly energy consumption for a given facility and then to save these results to a file for use in HPCALC. Although use of HEATLOAD is optional, it is recommended that the user employ HEATLOAD whenever possible. HEATLOAD is optional because HPCALC does not require access to a HEATLOAD data file. In HPCALC, the user is given the choice between using HEATLOAD-estimated loads or USER-estimated loads for the economic analysis.

To estimate energy consumption, HEATLOAD needs three sets of data:

1. Climate Region data,
2. Building Heat Use data, and
3. Building Floor Area data.

The user may modify any of these three sets of data. However, in order for any modifications in the data to become effective, HEATLOAD must be run using the new data.

Section II-3.2.1 contains a flow diagram of the HEATLOAD program. (Note: In order to save a new HEATLOAD data file, the user must follow the path on the flow diagram leading to the highlighted window.)

Section II-3.2.2 contains sample climate region data and identifies the source of this information.

Section II-3.2.3 contains sample building heat use data and identifies the source of this information.

Section II-3.2.4 contains a sample report for HEATLOAD.

3.2.1 HEATLOAD program flow diagram

Figure II-9 shows the flow of the HEATLOAD program.

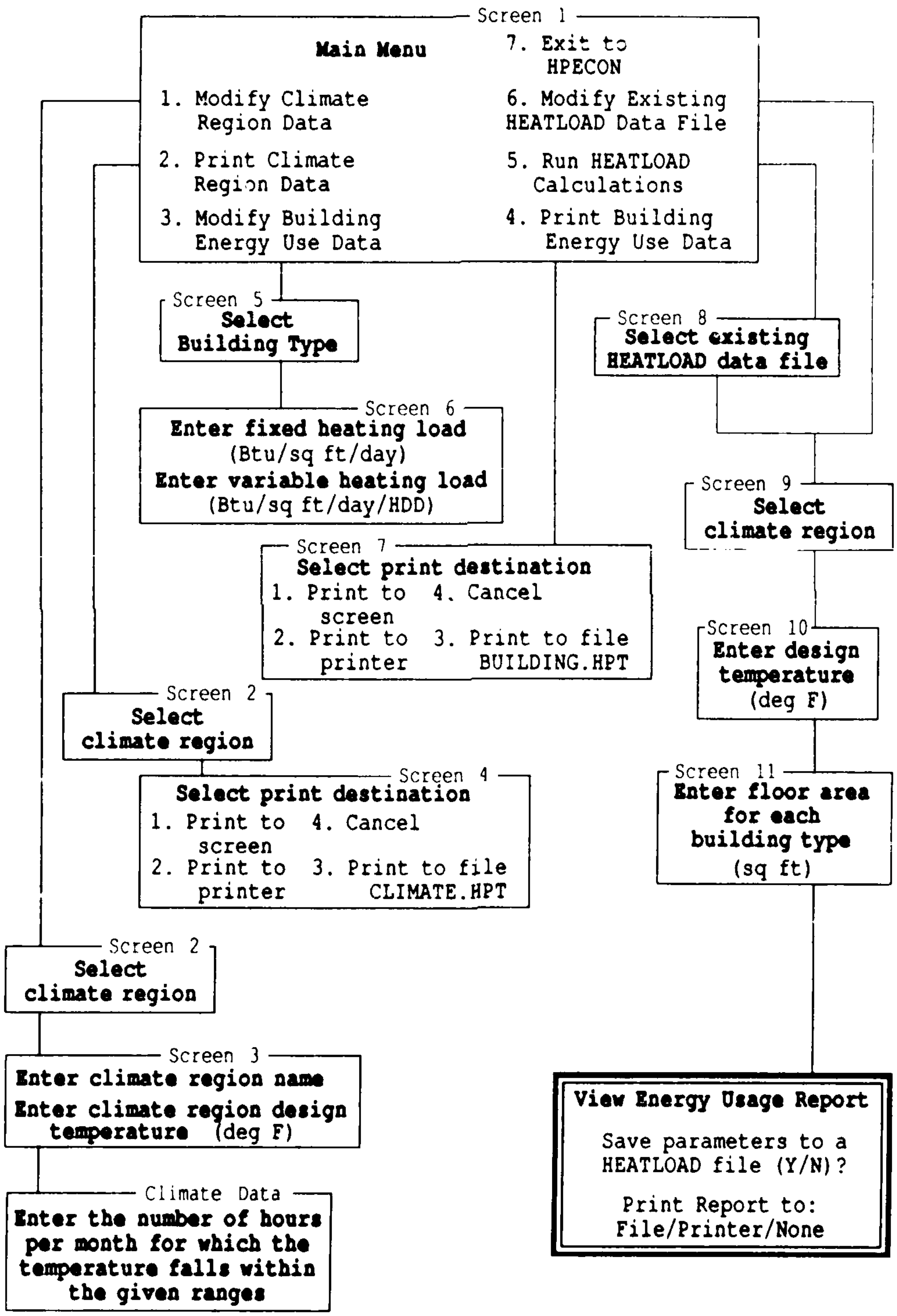

Figure II-9. HEATLOAD program flow diagram.

3.2.2 Sample climate region data

Figure II-10 illustrates the data stored for a single climate region.[6] Each column represents a month and each row represents a 5-degree Fahrenheit temperature range. Each number in the table indicates the average number of hours in a given month for which the outside air temperature falls within a certain 5-degree temperature range.[7]

Also included in the climate region data is a design temperature.[8] The design temperature is used to calculate the maximum design load for the plant.

Climate data file: SAMPLE REGION — Values in number of hours

TEMP DEG F	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR
65 to 69	121	134	109	113	126	95	26	5	2	3	18	60
60 to 64	132	81	43	51	102	112	55	11	5	6	26	85
55 to 59	116	53	16	27	85	123	81	25	13	18	46	103
50 to 54	83	22	3	7	49	114	108	37	21	29	64	116
45 to 49	47	6	0	1	22	82	107	61	49	48	104	112
40 to 44	24	2	0	0	8	56	114	102	87	96	137	91
35 to 39	8	0	0	0	1	39	97	129	117	123	133	44
30 to 34	2	0	0	0	0	18	72	147	144	130	108	23
25 to 29	0	0	0	0	0	5	36	105	122	107	54	7
20 to 24	0	0	0	0	0	0	9	65	80	55	26	1
15 to 19	0	0	0	0	0	0	1	34	53	28	6	0
10 to 14	0	0	0	0	0	0	0	16	28	17	2	0
5 to 9	0	0	0	0	0	0	0	3	14	6	1	0
0 to 4	0	0	0	0	0	0	0	1	5	2	0	0
-5 to -1	0	0	0	0	0	0	0	0	2	0	0	0
-10 to -6	0	0	0	0	0	0	0	0	1	0	0	0
-15 to -11	0	0	0	0	0	0	0	0	0	0	0	0
-20 to -16	0	0	0	0	0	0	0	0	0	0	0	0
-25 to -21	0	0	0	0	0	0	0	0	0	0	0	0
-30 to -26	0	0	0	0	0	0	0	0	0	0	0	0
-35 to -31	0	0	0	0	0	0	0	0	0	0	0	0

Design temp = 12 Degree F

Figure II-10. Sample climate region data.

[6] The user may specify seventeen different climate regions.

[7] Climate data can be found in the *Engineering Weather Data Handbook* (AFM 88-29 or TM 5-785 or NAVFAC P-89) under the heading, "Data for Use in Calculating Energy Consumption Estimates."

[8] Design temperature data can be found in the *Engineering Weather Data Handbook* (AFM 88-29 or TM 5-785 or NAVFAC P-89) under the heading, "Winter Design Data for Heating." The user should select the dry bulb temperature that is equaled or exceeded 97.5 percent of the time, on the average, during the coldest 3 consecutive months.

3.2.3 Sample building heat use data

Figure II-11 lists typical heat loads for buildings found on U.S. Army facilities. Each load is divided into a fixed and a variable component.

- The fixed component (Btu/sq ft/day) represents loads which remain relatively constant throughout the year such as domestic water heating.
- The variable component (Btu/sq ft/day/HDD) represents loads which fluctuate throughout the year such as space heating loads.

These loads are based on the findings of a USACERL study by Ben J. Sliwinski and Elizabeth Elischer.[9]

Values for file BUILHEAT.DAT (Building Heat Use Data)

Type of Building	Parameter	Current	Default	Minimum	Maximum
Family Housing......	Fixed Value	113.50	113.50	0.00	500.00
	Varia Value	16.50	16.50	0.00	100.00
Barracks, pre-1966..	Fixed Value	130.50	130.50	0.00	500.00
	Varia Value	15.90	15.90	0.00	100.00
Barracks, post-1966.	Fixed Value	81.90	81.90	0.00	500.00
	Varia Value	7.40	7.40	0.00	100.00
Barracks, modular...	Fixed Value	295.90	295.90	0.00	500.00
	Varia Value	34.30	34.30	0.00	100.00
Admin/Training Facil	Fixed Value	75.70	75.70	0.00	500.00
	Varia Value	18.90	18.90	0.00	100.00
Dining Facility.....	Fixed Value	241.90	241.90	0.00	500.00
	Varia Value	0.00	0.00	0.00	100.00
Medical/Dental Facil	Fixed Value	254.40	254.40	0.00	500.00
	Varia Value	24.30	24.30	0.00	100.00
Production/Maint Fac	Fixed Value	91.50	91.50	0.00	500.00
	Varia Value	31.40	31.40	0.00	100.00
Field Houses & Gyms.	Fixed Value	73.70	73.70	0.00	500.00
	Varia Value	32.40	32.40	0.00	100.00
Commissary.........	Fixed Value	147.00	147.00	0.00	500.00
	Varia Value	14.20	14.20	0.00	100.00
Storage Buildings...	Fixed Value	35.70	35.70	0.00	500.00
	Varia Value	36.10	36.10	0.00	100.00
User Defined Bldg...	Fixed Value	0.00	0.00	0.00	500.00
	Varia Value	0.00	0.00	0.00	100.00

Figure II-11. Sample building heat use data.

[9] Ben J. Sliwinski and Elizabeth Elischer, *Analysis of Facilities' Energy Use Patterns*, TR E-186/ADA132527 (USACERL, August 1983), p. 24, Table 15: "Summary of Regression Equations—Heating."

3.2.4 Sample HEATLOAD report

Figure II-12 shows a sample HEATLOAD energy usage report.

```
***************************************************************************
**                          H E A T L O A D                              **
**                        Energy Usage Report                            **
**                                                                       **
**  Date:  5/1/1990      Climate Region: SAMPLE REGION                   **
**  Title : SAMPLE REPORT                                                **
**  File  : K:\HEATLOAD\SAMPLE.HDA                                        **
***************************************************************************
                                         |
                                         |
                                         |
Month      Maximum         Average       |  Building               Building
           (MBtu/hr)       (MBtu/hr)     |  Type                   Area sq.ft.
-----      ---------       ---------     |  --------               -----------
                                         |
Jan          98.086          47.436      |  Family Housing......         75000
Feb          85.341          43.925      |  Barracks, pre-1966..             0
Mar          78.969          34.563      |  Barracks, post-1966.        100000
Apr          59.852          21.095      |  Barracks, modular...             0
May          47.107          12.341      |  Admin/Training Facil        200000
Jun          34.362           7.501      |  Dining Facility.....        100000
Jul          21.617           6.140      |  Medical/Dental Facil         50000
Aug          27.990           6.431      |  Production/Maint Fac        500000
Sep          40.734           9.399      |  Field Houses & Gyms.        100000
Oct          53.479          17.964      |  Commissary..........         75000
Nov          66.224          29.264      |  Storage Buildings...        100000
Dec          85.341          42.953      |  User Defined Bldg...             0
                                         |
---------------------------------------------------------------------------


Parasitic Load  =      5.686 (MBtu/hr)         Design Loads (MBtu/hr)
Total Building Area =   1300000 sq.ft          ----------------------
Heating Degree Days =     5001                  Maximum       73.234
-------------------------------------           Minimum        6.140
Total Load   =    202808.68 (MBtu/yr)           Average       23.152


Design Maximum Load at  12 degrees F.
```

Figure II-12. Sample HEATLOAD report.

3.3 HPCALC

To run HPCALC, choose option 3 from the HPECON Main Menu.

HPCALC performs an economic analysis of various fuel/technology combinations. The program generates seven reports based on entries by the user, data from HPDATA, and data from HEATLOAD (optional). The reports are headed:

1. Cost Summary
2. Run Data
3. Economic Summary
4. Demand Data Summary
5. Technology Data Summary
6. Capital Cost Summary
7. Operating Cost Summary.

These reports can be viewed and printed from within HPCALC or from the Main Menu of HPECON. HPCALC report files have the extension ".EPT".

The results of HPCALC can also be saved as an input file to LCCID. To do this, the user must choose to "create an LCCID input file" from screen 39 of HPCALC (see Figure II-13). Before the file is created, the user must name the file, specify a technology type, and list the information that will appear in the LCCID report's header. The header can specify the following information:

- Project number
- Project title
- Installation name
- Person doing study
- Design feature
- Plant location.

Valid plant locations include the 50 United States, Washington D.C., and outside the continental United States (OCONUS). Appendix C provides a complete listing of these valid location names.

Section II-3.3.1 contains a flow diagram of the HPCALC program. This three page diagram highlights the user inputs prompted by HPCALC.

Section II-3.3.2 contains a set of sample reports for HPCALC.

3.3.1 HPCALC program flow diagram

Figure II-13 shows the flow of the HPCALC program.

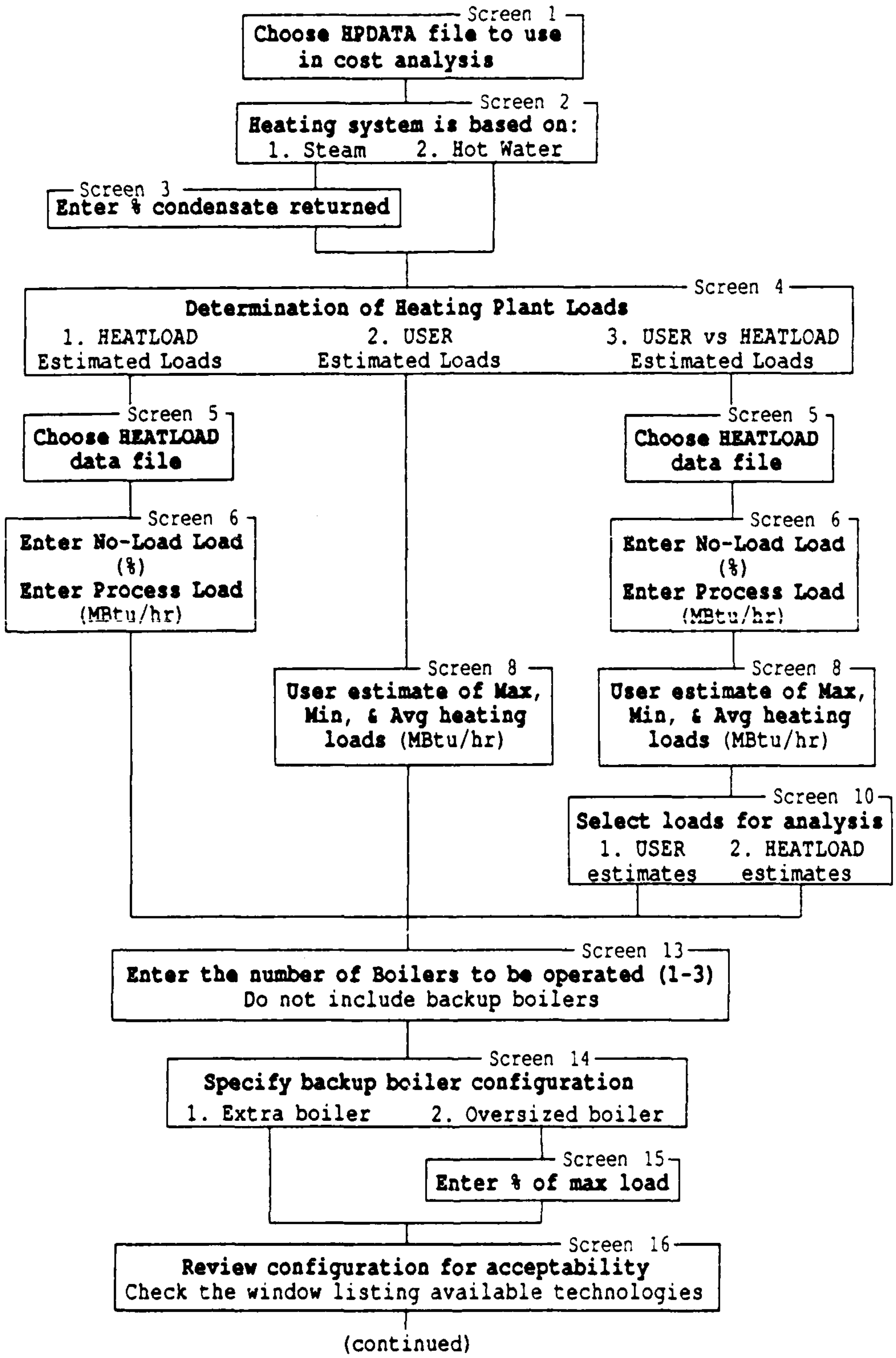

Figure II-13. HPCALC program flow diagram.

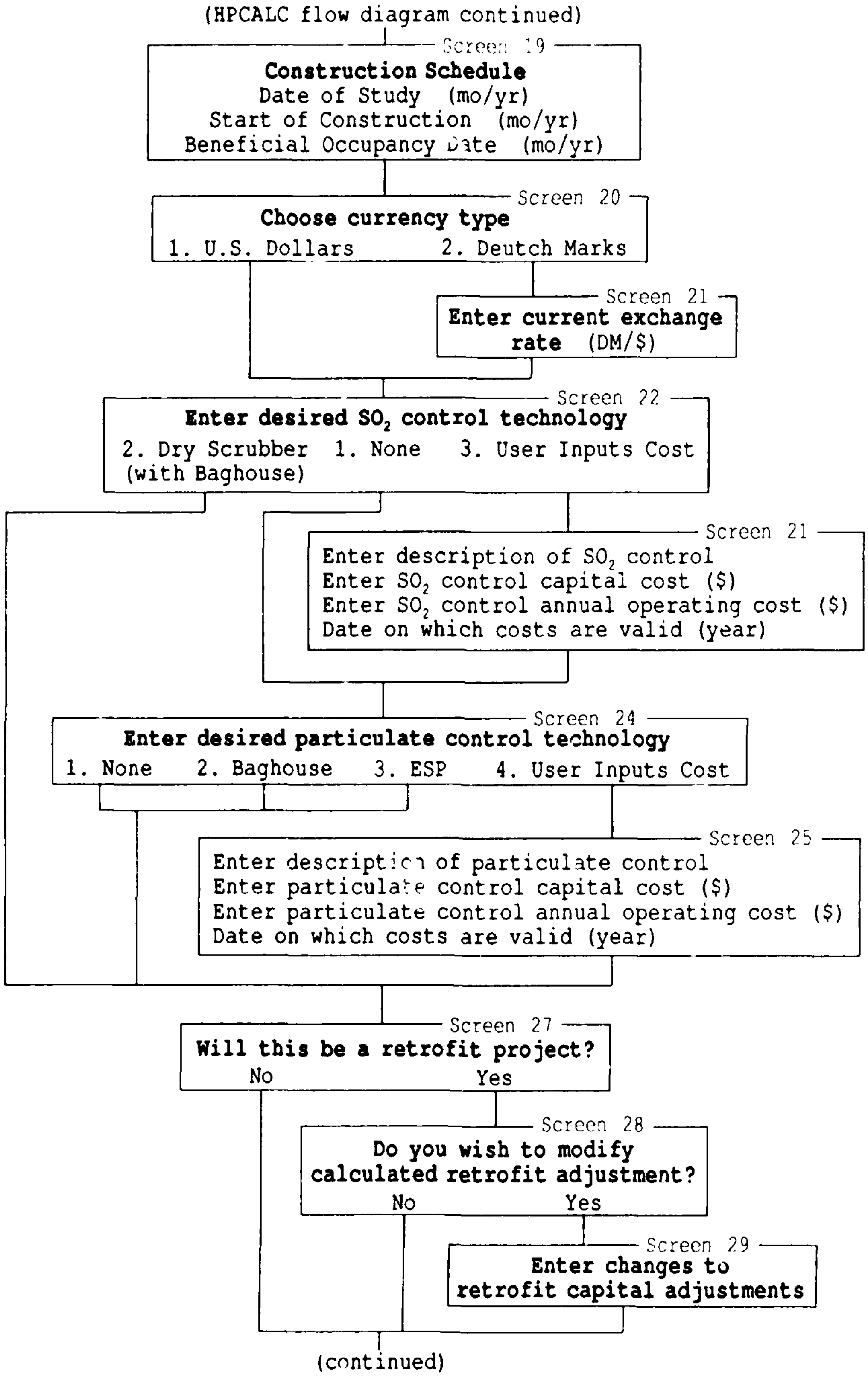

Figure II-13 (cont'd).

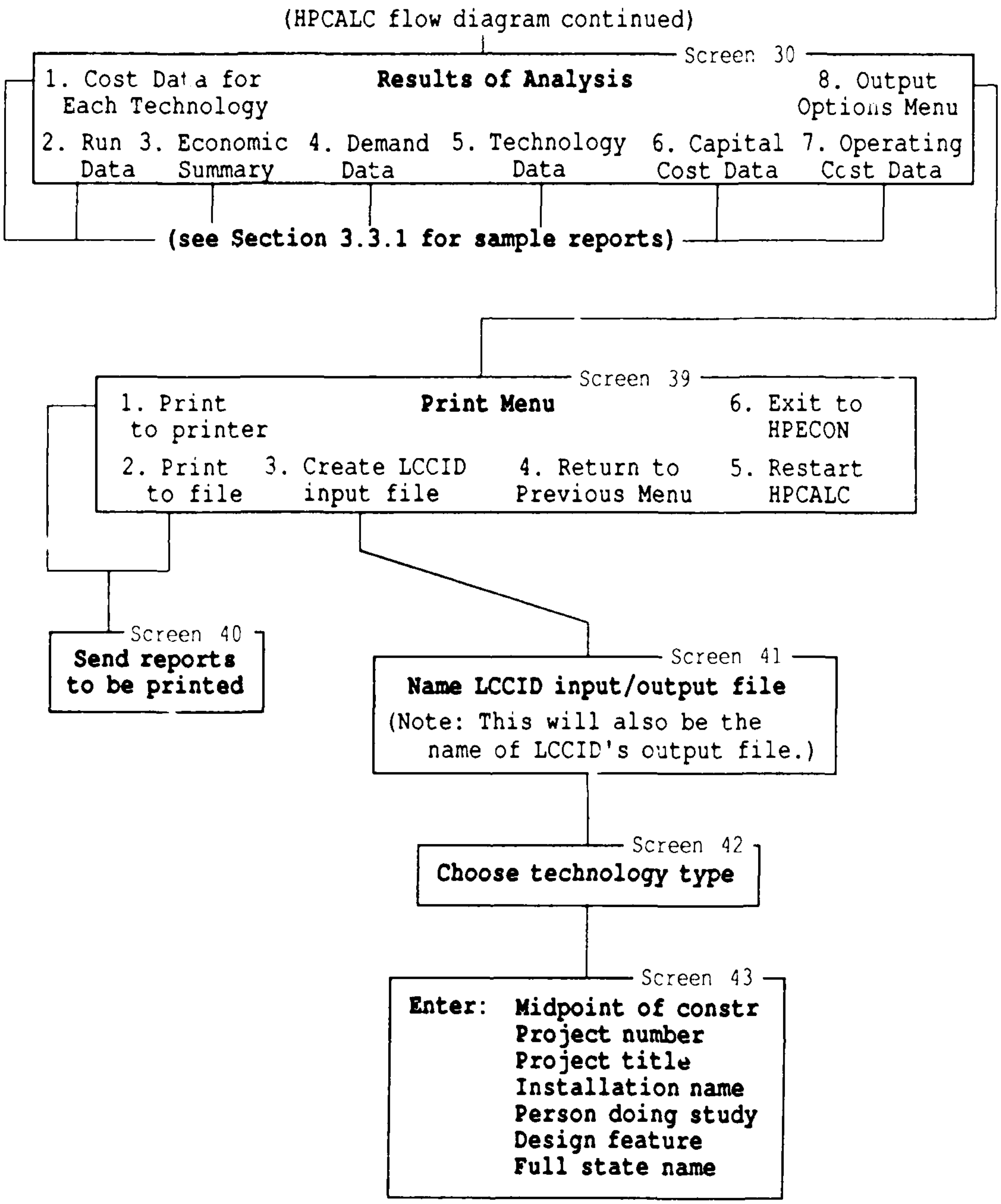

Figure II-13 (cont'd).

3.3.2 Sample HPCALC reports

Figures II-13 through II-19 illustrate the seven reports generated by HPCALC.

```
*****************************************************************************
**                              COST SUMMARY                               **
**                                                                         **
**   Title: SAMPLE REPORT                       Date: 5/ 1/1990            **
**   User : USACERL                             Basic Data: CERLDATA.CDA   **
**   DM conversion: None                     HEATLOAD File :   SAMPLE.HDA  **
*****************************************************************************

 *** Cost Summary for Technology # 2  (Coal-Sto wt:s)  IN DOLLARS

 CAPITAL COST                                 ANNUAL OPERATING COST
 Purchased Equipment........ =   3579957      Labor............. =    616672
 Balance of Plant........... =    894989      Maintenance....... =    160818
 Air Pol. Control (Partic).. =         0      Fuel.............. =    793402
 Air Pol. Control (SO2)      =   2019628      Water Treatment    =     27085
 Retrofit Adjustment........ =   -223747      Power............. =     45405
                                --------      APC (part)........ =         0
 Total Direct Capital Cost.. =   6270827      APC (SO2)......... =    532178
                                              Waste Disposal.... =     29039
 Engr,Des,Const Mgmt @ 30.0% =   1567707      Taxes, Ins etc.... =         0
                                --------
 Subtotal................... =   7838534

 Contingency ....@  20.0 %   =   1175780
                                --------                            --------
 Total Capital Cost......... =   9014314      Total Oper Cost    =   2204600
```

Figure II-14. Sample COST SUMMARY report for Coal-Sto wt:s.[10]

[10] Figure II-14 illustrates one part of a COST SUMMARY report. A complete report would contain cost summaries for all valid technology types. (Valid technology types are listed in Figure II-18.)

```
************************************************************************
**                            RUN DATA                                **
**                                                                    **
**  Title: SAMPLE REPORT                     Date: 5/ 1/1990          **
**  User : USACERL                           Basic Data: CERLDATA.CDA **
**  DM conversion: None                 HEATLOAD File :   SAMPLE.HDA  **
************************************************************************

Basic data file used = C:\HPDATA\CERLDATA.CDA
HEATLOAD file = C:\HEATLOAD\SAMPLE.HDA
Climate Region = SAMPLE REGION
Estimated or HEATLOAD loads used = HEATLOAD
Steam or hot water system =  steam
Percent condensate returned =  80.00
Backup configuration used   =  Extra Boiler
Retrofit Project            =  Yes
Particulate control         =  Baghouse
SO2 control                 =  Dry Scrubber w/ Baghouse
Study date          : Feb 1990
Start of constr.    : May 1990
Beneficial Occup. : May 1991
```

Figure II-15. Sample RUN DATA report.

```
************************************************************************
**                        ECONOMIC SUMMARY                            **
**                                                                    **
**  Title: SAMPLE REPORT                     Date: 5/ 1/1990          **
**  User : USACERL                           Basic Data: CERLDATA.CDA **
**  DM conversion: None                 HEATLOAD File :   SAMPLE.HDA  **
************************************************************************

VALUES ARE IN DOLLARS
```

TYPE TECHNOLOGY	TOTAL CAPITAL COST	ANNUAL NON-FUEL OPERATING COST	ANNUAL FUEL OPERATING COST
Coal-Sto wt:s	9014314	1411198	793402
#6 Oil wt:s	4894540	942811	1151943
#2 Oil wt:s	1850007	434869	1797963
Nat Gas wt:s	1850007	434869	1034474
Wood wt:s	9067642	1160326	1010191
Gas/2Oil wt:s	1850007	434869	1034474
2Oil/Gas wt:s	1850007	434869	1797963

Figure II-16. Sample ECONOMIC SUMMARY report.

```
***************************************************************************
**                        DEMAND DATA SUMMARY                            **
**                                                                       **
**  Title: SAMPLE REPORT                         Date: 5/ 1/1990         **
**  User : USACERL                               Basic Data: CERLDATA.CDA **
**  DM conversion: None                      HEATLOAD File :   SAMPLE.HDA **
***************************************************************************

Backup factor ...... =       1.00
Total capacity ..... =     130.39  MBtu/hr
Max Boiler output... =      81118  lbs/hr
Max Load ........... =      86.93  MBtu/hr
Min Load ........... =      19.83  MBtu/hr
Avg Load ........... =      36.84  MBtu/hr
Avg Availability.... =      99.91  % of time

Boiler configuration:
  Size "A":   3 at 43.46 MBtu/hr
  Size "B":   0 at  0.00 MBtu/hr
```

Figure II-17. Sample DEMAND DATA SUMMARY report.

```
***************************************************************************
**                      TECHNOLOGY DATA SUMMARY                          **
**                                                                       **
**  Title: SAMPLE REPORT                         Date: 5/ 1/1990         **
**  User : USACERL                               Basic Data: CERLDATA.CDA **
**  DM conversion: None                      HEATLOAD File :   SAMPLE.HDA **
***************************************************************************

 TYPE OF                TYPE              LIFE        EFF     AVAIL
 TECHNOLOGY             FUEL               YRS         %        %
 Coal-Sto ft:s  Technology outside capacity range ( 43.5 vs  5.0 to 20.0)
 Coal-Sto wt:s         Coal      - 4        25        75      99.70
 #6 Oil   ft:s  Technology outside capacity range ( 43.5 vs  5.0 to 20.0)
 #6 Oil   wt:s         No 6 Oil  - 2        25        80      99.99
 #2 Oil   ft:s  Technology outside capacity range ( 43.5 vs  5.0 to 25.0)
 #2 Oil   wt:s         No 2 Oil  - 1        25        80      99.99
 Nat Gas  ft:s  Technology outside capacity range ( 43.5 vs  5.0 to 25.0)
 Nat Gas  wt:s         Nat Gas   - 3        25        78      99.99
 Wood     wt:s         Wood      - 5        25        71      99.70
 Gas/2Oil ft:s  Technology outside capacity range ( 43.5 vs  5.0 to 25.0)
 Gas/2Oil wt:s         Nat Gas   - 3        25        78      99.99
 2Oil/Gas ft:s  Technology outside capacity range ( 43.5 vs  5.0 to 25.0)
 2Oil/Gas wt:s         No 2 Oil  - 1        25        80      99.99

"Technology outside capacity range" shows actual capacity
 vs the min and max capacity for which cost data are valid.
```

Figure II-18. Sample TECHNOLOGY DATA SUMMARY report.

```
******************************************************************************
**                          CAPITAL COST SUMMARY                            **
**                                                                          **
**  Title: SAMPLE REPORT                          Date: 5/ 1/1990           **
**  User : USACERL                                Basic Data: CERLDATA.CDA  **
**  DM conversion: None                       HEATLOAD File :   SAMPLE.HDA  **
******************************************************************************

VALUES ARE IN DOLLARS

 TYPE                      PRIMARY  BALANCE OF   OTHER   EDC   CONT    TOTAL
 TECHNOLOGY               EQ. COST  PLANT COST   COSTS    %     %      COSTS
 Coal-Sto wt:s             3579957     894989  1795881   25    15    9014314
 #6 Oil   wt:s             1231350     307838  1865709   25    15    4894540
 #2 Oil   wt:s             1143966     285991  -142996   25    15    1850007
 Nat Gas  wt:s             1143966     285991  -142996   25    15    1850007
 Wood     wt:s             4224855    1056214  1026857   25    15    9067642
 Gas/2Oil wt:s             1143966     285991  -142996   25    15    1850007
 2Oil/Gas wt:s             1143966     285991  -142996   25    15    1850007

       EDC = engineering, design, construction mgmt.
      CONT = allowance for contingencies
     OTHER = air pollution control + retrofit (if any)
```

Figure II-19. Sample CAPITAL COST SUMMARY report.

```
******************************************************************************
**                         OPERATING COST SUMMARY                           **
**                                                                          **
**  Title: SAMPLE REPORT                          Date: 5/ 1/1990           **
**  User : USACERL                                Basic Data: CERLDATA.CDA  **
**  DM conversion: None                       HEATLOAD File :   SAMPLE.HDA  **
******************************************************************************

VALUES ARE IN DOLLARS

 TYPE                           O&M       FUEL       APC      LABOR     TOTAL
 TECHNOLOGY                     COST      COST       COST      COST      COST

 Coal-Sto wt:s                233309    793402     561216    616672   2204600
 #6 Oil   wt:s                105103   1151943     504017    333691   2094754
 #2 Oil   wt:s                101177   1797963          0    333691   2232832
 Nat Gas  wt:s                101177   1034474          0    333691   1469343
 Wood     wt:s                262279   1010191     281375    616672   2170517
 Gas/2Oil wt:s                101177   1034474          0    333691   1469343
 2Oil/Gas wt:s                101177   1797963          0    333691   2232832

       APC = air pollution control cost and waste disposal
       O & M = maintenance, water, power, taxes and insurance
```

Figure II-20. Sample OPERATING COST SUMMARY report.

3.4 LCCID

The Life Cycle Cost in Design program (LCCID) performs a life cycle cost analysis for a selected heating plant configuration.

Section II-3.4.3 contains a sample report for LCCID.

Please note that all currency figures used and generated by LCCID are in U.S. dollars (while the results of HPCALC may appear in Deutsche marks).

3.4.1 Running LCCID as part of HPECON

To run LCCID from within HPECON, choose option 4 from the HPECON Main Menu. The user is asked to specify an LCCID input file created by HPCALC (a file with extension ".LCI"). An LCCID input file can be created at the end of each HPCALC session. (See section 3.3.1 for HPCALC's program flow.) This input file contains all of the data necessary to run LCCID. (See section III-6.31 for a detailed description of the input file.)

A report generated by LCCID can be viewed or printed using option 5 of the HPECON Main Menu. (LCCID report files have the extension ".RPT".)

Each execution of LCCID generates a ".LC" file. (If a file with the same name already exists, it is deleted before HPECON runs LCCID.) This file contains all of the input parameters for a particular run of LCCID. To perform a sensitivity analysis, it may be more convenient to modify an existing ".LC" file than to run HPECON repeatedly. Note that ".LC" files can only be modified when LCCID is run as a stand-alone program.

If LCCID fails to generate results during execution, the user may view the report file, ERROR.RPT, to identify the error. ERROR.RPT can be viewed by selecting option 5 from the HPECON Main Menu.

3.4.2 Running LCCID as a stand-alone program

To run LCCID as a stand-alone program, type "LCCID" from the root directory of the drive where the programs are installed. In this mode, the user must enter all data manually.

For more information concerning LCCID, refer to the LCCID User's Manual, or contact:

The BLAST Support Office
30 Mechanical Engineering Bldg.
1206 West Green Street
Urbana, IL 61801

3.4.3 Sample LCCID report

Figure II-21 shows a sample LCCID report.

```
                    LIFE CYCLE COST ANALYSIS                         STUDY: SAMPLE
LCCID  1.051                                       DATE/TIME:  05-01-90  10:48:37
PROJECT NO., FY, & TITLE: NONE   FY 90    SAMPLE REPORT
INSTALLATION & LOCATION: SAMPLE REGION
DESIGN FEATURE: RETROFIT PROJECT
ALT. ID. A;    TITLE: COAL-STO WT:S
NAME OF DESIGNER: USACERL

                      BASIC INPUT DATA SUMMARY

     CRITERIA REFERENCE:FEMP/10CFR436A  (Army TM 5-802-1, Para. 2-3&4)
                        DISCOUNT RATE: 7%


    KEY PROJECT-CALENDAR & ANALYSIS-TIMING-FRAMEWORK INFORMATION

 KEY PROJECT CALENDAR INFORMATION     ANALYSIS-TIMING-FRAMEWORK INFORMATION
 (DATES PER ACTUAL PROJECTIONS)       (DATES ASSUMED FOR ANALYSIS)

 DATE OF STUDY (DOS)          FEB 90    ANALYSIS BASE (ABD)             FEB 90
 MIDPOINT CONSTRUCTION (MPC)  NOV 90    MIDPOINT CONSTRUCTION (MPC)     FEB 90
 BENEFICIAL OCCUPANCY (BOD)   MAY 91    BENEFICIAL OCCUPANCY (BOD)      FEB 90
 END OF FACILITY LIFE (FLED)  MAY 16    ANALYSIS END (AED)              FEB 15

===========================================================================
  TYPE OF COST/BENEFIT    |            | EQUIVALENT |  TIME(S) COST INCURRED*
==========================|    COST    |  UNIFORM   |===========|===========
    |                     |            |DIFFERENTIAL|  ACTUAL   |  PAYMENT
COST|   COST / BENEFIT    |  IN ABD $  | ESCALATION | PROJECTED |   DATES
CODE|    DESCRIPTION      |            |    RATE    | PAYMENT   |    FOR
    |                     |($ X 10**3)|(% PER YEAR)|  DATES    |  ANALYSIS
====|=====================|===========|============|===========|===========
II  |INVESTMENT           |    7973.0 |        .00 |   NOV 90  |   FEB 90
EN  |COAL                 |     793.4 |     ****** |MAY92-MAY16|FEB91-FEB15
MR  |LABOR                |     616.7 |        .00 |MAY92-MAY16|FEB91-FEB15
MR  |AIR POLL CNTR        |     561.2 |        .00 |MAY92-MAY16|FEB91-FEB15
MR  |MAINT, POWER, OTHER  |     233.3 |        .00 |MAY92-MAY16|FEB91-FEB15
===========================================================================

                        OTHER KEY INPUT DATA

          LOCATION   - VIRGINIA              CENSUS REGION:  3
          RATES FOR INDUSTRIAL  SECTOR.

    ENERGY USAGE:  10**6 BTUS       ELECTRIC DEMAND: 10**3 DOLLARS
  ENERGY TYPE      $ / MBTU    AMOUNT    ELECT. DEMAND        PROJECTED DATES
 COAL                  1.84  430341.3                         MAY91-MAY16
```

Figure II-21. Sample LCCID report.

```
                     LIFE CYCLE COST ANALYSIS                    STUDY: SAMPLE
LCCID  1.051                                   DATE/TIME:  05-01-90  10:48:37
PROJECT NO., FY, & TITLE: NONE   FY 90    SAMPLE REPORT
INSTALLATION & LOCATION: SAMPLE REGION
DESIGN FEATURE: RETROFIT PROJECT
ALT. ID. A;    TITLE: COAL-STO WT:S
NAME OF DESIGNER: USACERL


                       FUEL & NON FUEL ESCALATION VALUES

          LOCATION - VIRGINIA                 CENSUS REGION:  3
          RATES FOR INDUSTRIAL  SECTOR.

          ENERGY ESCALATION VALUES (JAN 1990):

  ENERGY TYPE      1990  1991  1992  1993  1994  1995  1996  1997  1998
  COAL             2.24   .31   .51   .52   .61  1.10   .73  1.08  1.24

  ENERGY TYPE      1999  2000  2001  2002  2003  2004  2005  2006  2007
  COAL              .85 00.00 00.00  1.26  1.10  1.42  1.32  1.11   .99

  ENERGY TYPE      2008  2009  2010  2011  2011  2012  2013 >2014
  COAL             1.34  1.44  1.14  1.10  1.47  1.47  1.47  1.47


                    M&R and Custodial Costs

    ANNUAL VALUE: LABOR
    ESCALATION VALUE: NONE

     90-**
     00.00

    ANNUAL VALUE: AIR POLL CNTR
    ESCALATION VALUE: NONE

     90-**
     00.00

    ANNUAL VALUE: MAINT, POWER, OTHER
    ESCALATION VALUE: NONE

     90-**
     00.00

                    Major Repair & Replacement Costs

                    Other O&M Costs & Monetary Benefits

                    Pre-BOD Costs & Benefits
```

Figure II-21 (cont'd).

```
                    LIFE CYCLE COST ANALYSIS                          STUDY: SAMPLE
LCCID  1.051                                    DATE/TIME:  05-01-90  10:48:37
PROJECT NO., FY, & TITLE: NONE   FY 90    SAMPLE REPORT
INSTALLATION & LOCATION: SAMPLE REGION
DESIGN FEATURE: RETROFIT PROJECT
ALT. ID. A;   TITLE: COAL-STO WT:S
NAME OF DESIGNER: USACERL


                       LIFE CYCLE COST TOTALS*


    INITIAL INVESTMENT COSTS                               7176.


    ENERGY COSTS:

    COAL                                      10121.

    TOTAL ENERGY COSTS                                    10121.


    RECURRING M&R/CUSTODIAL COSTS                         16446.

    MAJOR REPAIR/REPLACEMENT COSTS                            0.

    OTHER O&M COSTS & MONETARY BENEFITS                       0.

    DISPOSAL COSTS/RETENTION VALUE                            0.


    LCC OF ALL COSTS/BENEFITS (NET PW)                    33742.


  *NET PW EQUIVALENTS ON FEB90; IN 10**3 DOLLARS; IN CONSTANT FEB90 DOLLARS
  *ENERGY ESCALATION VALUES FROM TABLES OF JAN90
```

Figure II-21 (cont'd).

LIFE CYCLE COST ANALYSIS STUDY: SAMPLE
LCCID 1.051 DATE/TIME: 05-01-90 10:48:37
PROJECT NO., FY, & TITLE: NONE FY 90 SAMPLE REPORT
INSTALLATION & LOCATION: SAMPLE REGION
DESIGN FEATURE: RETROFIT PROJECT
ALT. ID. A; TITLE: COAL-STO WT:S
NAME OF DESIGNER: USACERL

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**3

BENEFICIAL OCCUPANCY DATE: MAY91
ACTUAL ANNUAL PAYMENTS OCCUR: MAY92 THROUGH MAY16
ANNUAL PAYMENTS FOR ANALYSIS OCCUR: FEB91 THROUGH FEB15

PAY	COAL	M & R	R / R	OTHER
1	758.1	1318.9	.0	.0
2	710.7	1232.6	.0	.0
3	667.6	1152.0	.0	.0
4	627.2	1076.6	.0	.0
5	589.7	1006.2	.0	.0
6	557.2	940.3	.0	.0
7	524.5	878.8	.0	.0
8	495.5	821.3	.0	.0
9	468.9	767.6	.0	.0
10	441.9	717.4	.0	.0
11	413.0	670.4	.0	.0
12	386.0	626.6	.0	.0
13	365.3	585.6	.0	.0
14	345.1	547.3	.0	.0
15	327.1	511.5	.0	.0
16	309.8	478.0	.0	.0
17	292.7	446.7	.0	.0
18	276.3	417.5	.0	.0
19	261.7	390.2	.0	.0
20	248.1	364.7	.0	.0
21	234.5	340.8	.0	.0
22	221.5	318.5	.0	.0
23	210.1	297.7	.0	.0
24	199.2	278.2	.0	.0
25	188.9	260.0	.0	.0
**	10120.6	16445.5	.0	.0

*NET PW EQUIVALENTS ON FEB90; IN 10**3 DOLLARS; IN CONSTANT FEB90 DOLLARS
*ENERGY ESCALATION VALUES FROM TABLES OF JAN90

Figure II-21 (cont'd).

3.5 Print/View a File

To print or view a HEATLOAD, HPCALC, or LCCID report file (extensions ".HPT", ".EPT", and ".RPT", respectively), choose option 5 from the HPECON Main Menu.

On the first screen, use the arrow keys to highlight the desired selection. To change directories or drives, highlight the appropriate directory or drive name and press <Enter>. (If HPECON was installed using the default directory names, then ".EPT" and ".RPT" files are located on the directory "HPDATA", and ".HPT" files are located on the directory "HEATLOAD.")

Once the desired file name is highlighted, do one of the following:

- Press <F1> to view the file
- Press <F2> to print the file
- Press <Esc> to return to the HPECON Main Menu.

4. ADMINISTRATIVE FUNCTIONS

Administrative functions are available to those individuals who know the passwords to the programs HPCREATE.EXE and HLCREATE.EXE. With these additional programs, the system administrator may change minimum, maximum, and default values for the parameters contained in HPDATA and HEATLOAD data files.

WARNING: The system administrator should exercise caution before making changes to the database. Unjustifiable changes can render the results of HPECON unreliable.

4.1 HPCREATE

To run the HPCREATE program, press <F10> while viewing the HPECON program's main menu. The <F10> key will activate HPCREATE if the program is available.

HPCREATE is a program which allows the system administrator to change the minimum, maximum, and default values for the economic and technical data stored in HPDATA. It also allows the administrator to classify the available technologies. The administrator may modify any of the following data tables:

Table 1 — fuels
Table 2 — technology types
Table 3 — capital costs
Table 4 — O&M costs
Table 5 — miscellaneous parameters
Table 6 — capital cost indices
Table 7 — O&M cost indices
Table 8 — technology names.

To modify a file, use the <Tab> key to move the cursor horizontally, and the arrow keys to move the cursor vertically.

NOTE: The limits and default values for the file CERLDATA.CDA cannot be altered using HPCREATE.

Sections II-3.1.2 through II-3.1.8 contain samples of the data tables (1) through (7).

Table II-4 contains a listing of the technology names that may be modified (data table 8).

For help with the flow of HPCREATE, the administrator should refer to the flow diagram for HPDATA, Figure II-1.

4.2 HLCREATE

To run the HLCREATE program, press <F10> while viewing the HEATLOAD program's main menu. The <F10> key will activate HLCREATE if the program is available.

HLCREATE is a program which allows the system administrator to change the minimum, maximum, and default values for the building data stored in HEATLOAD.

To modify a file, use the <Tab> key to move the cursor horizontally, and the arrow keys to move the cursor vertically.

Figure II-11 lists building heat use data and identifies the source of this information.

Figure II-9 contains a flow diagram for the HEATLOAD program. Screens 5 and 6 of this diagram describe the flow of HLCREATE.

III HPECON TECHNICAL REFERENCE

1. HPECON SYSTEM MATERIALS

HPECON includes the following materials:

1. Six 5 1/4" floppy disks
2. User's Manual/Technical Reference.

Below is a listing of the files contained on each numbered disk. The user should make backup copies of the disks to ensure against accidental loss.

<u>DISK 1 - HPECON-Program</u>

Supplied on Disk: (HPSETUP.DAT is created if missing)

DISK1	HPDATA.EXE	HPECON.EXE
HPMENU.DAT	HPCALC.EXE	HPVIEW.EXE

Files Created By HPSETUP: (created if missing)
HPSETUP.DAT

User Supplied Files: COMMAND.COM

<u>DISK 2 - HPECON-System</u>

Supplied on Disk:

DISK2	F$FND	
SAMPLE.HDA	SAMPLE.LCI	HPSETUP.EXE
SAMPLE.HPT	SAMPLE.LC	HPCREATE.EXE*
SAMPLE.EPT	SAMPLE.RPT	CERLDATA.CDA

<u>DISK 3 - HEATLOAD-Progam</u>

Supplied on Disk:

DISK3	BUILHEAT.DAT	
CLIMATE.DAT	CLIMNAME.DAT	HEATLOAD.EXE
DESIGNM.DAT	BUILDING.DAT	HLCREATE.EXE*

---

* Note: This program is available to people who know the password.

DISK 4 - HPECON-Sample Data

Supplied on Disk: (Sample input and output data files)

DISK4	SAMPLE.HDA	SAMPLE.LC
CENRFL.DAT	SAMPLE.HPT	SAMPLE.RPT
EVAL90.DAT	SAMPLE.EPT	CERLDATA.CDA
UPW90.DAT	SAMPLE.LCI	HELPFL.DAT(0K)

User Created Data Disk Files: (written by HPSETUP)

DISK4	EVAL90.DAT	CERLDATA.CDA
CENRFL.DAT	UPW90.DAT	HELPFL.DAT(0K)

DISK 5 - LCCID-1, version 1, level 51

Supplied on Disk: USACERL.PAG README.DOC DOD.MSG
LCCID.EXE DOE.MSG

Files Created By LCCID: (created during each run of LCCID)
F$FND F$FND.RPT

Files Created By HPECON: (created if missing)
LCCID.INI HPMENU.DAT F$FND
F$FND.RPT

User Supplied Files: COMMAND.COM

DISK 6 - LCCID-2, version 1, level 51

Supplied on Disk:

LCCIDINI.EXE	EVAL88.DAT	UPW88.DAT
CENRFL.DAT	EVAL90.DAT	UPW90.DAT
HELPFL.DAT(55K)		

2. UNITS OF MEASURE

Table III-1 lists the units of measure used by HPECON.

Table III-1
Units of Measure

Measure	Abbreviation	Term
Time	hr	Hour
	yr	Year
Area	sq ft	Square feet
Volume	cf	Cubic feet
	kscf	1000 standard cubic feet
	gal	Gallons
Mass	lbm	Pounds mass
Force	lb	Pounds force
	psig	Pounds per square inch gauge
	ton	2000 pounds
Energy	Btu	British thermal unit
	MBtu	One million British thermal units
Power	kWh	Kilowatt-hour
Temperature	deg F	Degrees Fahrenheit
	HDD	Heating degree days
Currency	$	U.S. dollars
	DM	Deutsche marks
Ratios	%	Percent

3. PARAMETER DEFINITIONS

This section defines the parameters stored in HPDATA and HEATLOAD data files. The section also defines the parameters entered by the user in HPCALC.

3.1 HPDATA

This section defines the parameters stored in HPDATA data files.

3.1.1 FUELS data table

The parameters defined in this section are stored for each of the fuel types listed in Table III-2.

Table III-2
Fuel Types

Fuel Type	Fuel Type
Type 1 - No 2 Oil	Type 4 - Coal
Type 2 - No 6 Oil	Type 5 - Wood
Type 3 - Natural Gas	Type 6 - Option 1*

1. HHV: higher heating value; the total energy released from the combustion of a specified amount of fuel at 60 deg F when the products of combustion have cooled to 60 deg F.
   Units: Btu/lb — No. 2 Oil
   Btu/lb — No. 6 Oil
   Btu/cf — Natural Gas
   Btu/lb — Coal
   Btu/lb — Wood
   Btu/lb — Option 1

2. Conversion Factor: a conversion factor for each fuel type. The factor is used in the cost calculations.
   Units: lb/gal — No. 2 Oil
   lb/gal — No. 6 Oil
   cf/kscf — Natural Gas
   lb/ton — Coal
   lb/ton — Wood
   lb/gal — Option 1

3. Sulfur: the weight of sulfur contained in the fuel as a percentage of the fuel's weight (on an "as fired" basis).
   Units: percent

* Note: Option 1 must be a liquid fuel having the units listed in the definitions.

4. Ash: the weight of noncombustible mineral matter contained in the fuel as a percentage of the fuel's weight (on an "as fired" basis).
   Units: percent

5. Moisture: the weight of water (liquid or vapor) contained in the fuel as a percentage of the fuel's weight.
   Units: percent

3.1.2 TECHNOLOGY TYPES data table

The parameters defined in this section are stored for each of the technology types listed in Table III-3.*

Table III-3
Technology Types

Technology Type		Technology Type		Technology Type	
Coal-Sto	ft:s	Nat Gas	ft:w	2Oil/Gas	ft:w
Coal-Sto	wt:s	Nat Gas	ft:s	2Oil/Gas	ft:s
No 6 Oil	ft:s	Nat Gas	wt:s	2Oil/Gas	wt:s
No 6 Oil	wt:s	Wood	wt:s	Other 1	??:?
No 2 Oil	ft:w	Gas/2Oil	ft:w	Other 2	??:?
No 2 Oil	ft:s	Gas/2Oil	ft:s	Other 3	??:?
No 2 Oil	wt:s	Gas/2Oil	wt:s		

Where: ft = fire-tube, s = steam; wt = water-tube, w = hot water; ?? = not defined, ? = not defined

1. Size: the allowable size range for a single boiler as determined by the maximum output for which the boiler can be safely operated.
   Units: MBtu/hr

2. Fuel Type: an integer which identifies the fuel type to the computer.
   Units: integer
   1 — No 2 Oil
   2 — No 6 Oil
   3 — Natural Gas
   4 — Coal
   5 — Wood
   6 — Option 1

3. Boiler Efficiency: the ratio of usable boiler output to input as defined by the ASME Power Test Code. This value for efficiency includes boiler blowdown as well as the performance of the deaerator and the feedwater heater.
   Units: percent

* Note: For dual-fuel technologies, the first fuel listed is the primary fuel.

4. Parasitic Power: the power load due to auxiliary components other than those defined under *Boiler Efficiency*, expressed as a percentage of the total annual load. All of these auxiliary components are assumed to be electrically driven (e.g., pumps and fans).
   Units: percent

5. Asset Life: the expected life of plant assets. Note that according to the Federal Standard (FEDS), the economic life expectancy for a project should not exceed 25 years.
   Units: years

6. Forced Outage Rate: the percentage of time a boiler is out of operation due to unforeseen events.
   Units: percent

7. Planned Outage Rate: the percentage of time a boiler is out of operation due to scheduled events.
   Units: percent

8. Op Labor: operational labor; number of persons per shift needed to operate one boiler, not including supervision.
   Units: men/shift

9. Super Labor: supervisory labor; number of persons per day needed to supervise a boiler plant.
   Units: men/day

10. Maint cost: maintenance cost; maintenance cost as a percentage of total capital cost. The maintenance cost does not include air pollution control costs.
    Units: percent

11. Unit mult: unit multiplier for operational labor; a multiplier which scales the quantity of operational labor needed to operate each boiler when the plant being considered contains more than one boiler. The multiplier is not used for the first boiler, nor is it used for the backup boiler (if one is assigned).
    Units: scalar

3.1.3 CAPITAL COSTS data table

The parameters defined in this section are stored for each technology type. (Table III-3 contains a listing of the technology types.)

1. Equip Cost a: purchased equipment cost coefficient; the y-intercept of a line fit to a log-log graph plotting boiler capital cost ($1,000) versus boiler size (MBtu/hr).
   Units: $1,000/MBtu/hr

2. Equip Cost b: purchased equipment cost exponent; the slope of a line fit to a log-log graph plotting boiler capital cost ($1,000) versus boiler size (MBtu/hr).
   Units: scalar

3. BOP Equip Cost: balance of plant equipment cost; the capital cost of boiler plant support equipment (pumps, piping, etc.) as a percentage of primary equipment (boilers).
   Units: percent

4. APC-Baghouse: baghouse cost coefficient; the y-intercept of a line fit to a log-log graph plotting baghouse capital cost ($) versus boiler size (MBtu/hr).
   Units: $/MBtu/hr

5. APC-SO2: dry scrubber cost coefficient; the y-intercept of a line fit to a log-log graph plotting dry scrubber capital cost ($) versus boiler size (MBtu/hr).
   Units: $/MBtu/hr

6. APC-ESP: electro-static precipitator cost coefficient; the y-intercept of a line fit to a log-log graph plotting ESP capital cost ($) versus boiler size (MBtu/hr).
   Units: $/MBtu/hr

7. Retrofit Adjustment: the retrofit adjustment is expressed as a percentage of the balance of plant (BOP) cost. The BOP cost multiplied by the retrofit adjustment reflects the BOP costs or savings associated with modifying an existing power plant. If the retrofit adjustment is less than 100 percent, the retrofit will reduce capital costs. If the retrofit adjustment is greater than 100 percent, the retrofit will increase capital costs.
   Units: percent

3.1.4 O&M COSTS data table

The dollar cost for each parameter described below must be in *base year* dollars. The base year is specified as the "Yr of annual cost data" in the MISCELLANEOUS PARAMETERS data table. (See section III-3.1.5 for a description of this variable.)

1. RR of Esca: real rate of price escalation; the annual increase or decrease in the cost of a product (excluding inflation or deflation) as a percentage of its unit cost in the base year.
   Units: percent

2. Water Treat: water cost, including treatment; the cost of purchasing and treating 1,000 gallons of boiler make-up water.
   Units: $/1,000 gal

3. Oper-Labor: operational labor; the hourly cost for one operations laborer including all overheads.
   Units: $/manhr

4. Super-Labor: supervisory labor; the hourly cost for one supervisor including all overheads.
   Units: $/manhr

5. Fuel: #2 Oil: the delivered cost for 1 gallon of Number 2 distilled oil.
   Units: $/gal

6. Fuel: #6 Oil: the delivered cost for 1 gallon of Number 6 residual oil.
   Units: $/gal

7. Fuel: NatG: natural gas; the delivered cost for 1,000 standard cubic feet of natural gas.
   Units: $/kscf

8. Fuel: Coal: the delivered cost for 1 ton of coal.
   Units: $/ton

9. Fuel: Wood: the delivered cost for 1,000 standard cubic feet of wood suitable for boiler application.
   Units: $/ton

10. Fuel: Option 1: the delivered cost for 1 gallon of a liquid fuel as specified by the user.
    Units: $/gal

11. Purch Elec: purchased electricity; the unit cost for electricity (used to power electrical controls, lights, pumps, etc.).
    Units: $/kWh

12. Waste Disposal: the unit cost for waste disposal, including dump site charges and transportation.
    Units: $/ton

13. Lime: the delivered cost for 1 ton of 90 percent pure quicklime, CaO (used in dry scrubber to remove sulfur).
    Units: $/ton

14. Baghouse fixed exp: baghouse fixed exponent; the slope of a line fit to a log-log graph plotting baghouse O&M cost ($) versus boiler size (MBtu/hr).
    Units: scalar

15. Baghouse fixed coef: baghouse fixed coefficient; the y-intercept of a line fit to a log-log graph plotting baghouse O&M cost ($) versus boiler size (MBtu/hr).
Units: $/MBtu/hr

16. Baghouse varia coef: baghouse variable coefficient; the baghouse O&M cost due to the annual plant load (MBtu/yr).
Units: $/MBtu/yr

17. ESP fixed exp: electro-static precipitator fixed exponent; the slope of a line fit to a log-log graph plotting ESP O&M cost ($) versus boiler size (MBtu/hr).
Units: scalar

18. ESP fixed coef: electro-static precipitator fixed coefficient; the y-intercept of a line fit to a log-log graph plotting ESP O&M cost ($) versus boiler size (MBtu/hr).
Units: $/MBtu/hr

19. ESP varia coef: electro-static precipitator variable coefficient; the ESP O&M cost due to the annual plant load (MBtu/yr).
Units: $/MBtu/yr

20. Dry Scrub fixed exp: SO_2 dry scrubber fixed exponent; the slope of a line fit to a log-log graph plotting dry scrubber O&M cost ($) versus boiler size (MBtu/hr).
Units: scalar

21. Dry Scrub fixed coef: SO_2 dry scrubber fixed coefficient; the y-intercept of a line fit to a log-log graph plotting dry scrubber O&M cost ($) versus boiler size (MBtu/hr).
Units: $/MBtu/hr

22. Dry Scrub varia coef: SO_2 dry scrubber variable coefficient; the dry scrubber O&M cost due to the annual plant load (MBtu/yr).
Units: $/MBtu/yr

3.1.5 MISCELLANEOUS PARAMETERS data table

1. Engr,Des,Constr Mgmt: the cost of engineering, design, and construction management (EDC) as a percentage of capital cost.
Units: percent

2. Cap Cost Contingency: capital cost contingency; the cost of unforeseen events as a percentage of the capital cost (including *Engr,Des,Constr Mgmt* cost).
Units: percent

3. <u>Discount Rate</u>: the rate of interest which reflects an investor's time value of money. The discount rate is used to convert cash flows to a common time. HPECON assumes a discount rate of 10 percent.
Units: percent

4. <u>Taxes and Insurance</u>: the cost of taxes and insurance as a percentage of the total capital cost. (Note that U.S. Government facilities do not pay taxes, nor do they pay for insurance.)
Units: percent

5. <u>Yr of annual cost data</u>: the year for which annual cost data entered into the O&M Cost Data Table is accurate.
Units: year

6. <u>Inflation</u>: the annual rate of inflation.
Units: percent

7. <u>Turn Down Ratio : Coal</u>: the ratio of a coal boiler's design load to its minimum load.
Units: scalar

8. <u>Turn Down Ratio : Oil</u>: the ratio of an oil boiler's design load to its minimum load.
Units: scalar

9. <u>Turn Down Ratio : Gas</u>: the ratio of a gas boiler's design load to its minimum load.
Units: scalar

10. <u>Turn Down Ratio : Wood</u>: the ratio of a wood boiler's design load to its minimum load.
Units: scalar

11. <u>Stoichiometric Ratio</u>: a ratio which indicates the number of units of lime (CaO) used to remove one unit of sulfur (SO_2). The ratio must be greater than or equal to one.
Units: scalar

3.1.6 CAPITAL COST INDICES data table

1. Reference Year of cost data: the year for which capital cost data is accurate. (Note that this model uses 1987 cost data.)
   Units: year

2. Current Index: the current index reflects the yearly capital cost escalation.[11]
   Units: scalar

3. Calculated Rate: the yearly capital cost escalation expressed as a percentage. (Note that this value is provided as a reference to the user. It is not used in any calculations.)
   Units: percent

3.1.7 O&M COST INDICES data table

1. Reference Year of cost data: the year for which O&M cost data is accurate.
   Units: year

2. Current Index: the current index reflects the yearly O&M cost escalation.[12]
   Units: scalar

3. Calculated Rate: the yearly O&M cost escalation expressed as a percentage. (Note that this value is provided as a reference to the user. It is not used in any calculations.)
   Units: percent

[11] The capital cost indices are the "annual indices" as obtained from *Chemical Engineering Magazine's* CE PLANT COST INDEX.

[12] The operations and maintenance cost indices are the "annual indices" as obtained from *Chemical Engineering Magazine's* MARSHALL & SWIFT EQUIPMENT COST INDEX.

3.2 HEATLOAD

This section defines the parameters stored in HEATLOAD data files.

3.2.1 Climate region data

1. Number of hours: each number in the table indicates the average number of hours in a given month for which the outside air temperature falls within a certain 5 deg F temperature range.[13]
   Units: hours

2. Design temp: design temperature; the dry bulb temperature that is equaled or exceeded 97.5 percent of the time, on the average, during the coldest three consecutive months.[14]
   Units: deg F

3.2.2 Building heat use data

1. Fixed Value: represents loads which remain relatively constant throughout the year such as domestic water heating.
   Units: Btu/sq ft/day

2. Varia Value: variable value; represents loads which fluctuate throughout the year such as space heating loads.
   Units: Btu/sq ft/day/HDD

[13] Climate data can be found in the *Engineering Weather Data Handbook* (AFM 88-29 or RM 5-785 or NAVFAC P-89) under the heading, "Data for Use in Calculating Energy Consumption Estimates."

[14] Design temperature data can be found in the *Engineering Weather Data Handbook* (AFM 88-29 or RM 5-785 or NAVFAC P-89) under the heading, "Winter Design Data for Heating."

3.3 HPCALC

This section defines the parameters entered by the user in HPCALC.

1. Condensate returned: the percentage of water leaving the steam boiler which returns as liquid water. Returning condensate is assumed to be at 180 deg F.
   Units: percent

2. Maximum load: estimated maximum plant load.
   The HEATLOAD-estimated load does not include "no-load load" and "process load."
   The USER-estimated load includes "no-load load" and "process load."
   Units: MBtu/hr

3. Minimum load: estimated minimum plant load.
   The HEATLOAD-estimated load does not include "no-load load" and "process load."
   The USER-estimated load includes "no-load load" and "process load."
   Units: MBtu/hr

4. Average load: estimated average plant load.
   The HEATLOAD-estimated load does not include "no-load load" and "process load."
   The USER-estimated load includes "no-load load" and "process load."
   Units: MBtu/hr

5. No-load load: the load associated with a steam or hot water distribution system (e.g., thermal and leak losses) as a percentage of the maximum plant load. Maximum plant load includes "no-load load" and "process load."
   Units: percent

6. Process load: the constant load placed on the system due to manufacturing processes.
   Units: MBtu/hr

7. Number of Boilers: the number of boilers used to satisfy the maximum plant load. This number does not include a backup boiler.
   Units: MBtu/hr

8. Oversizing: the percentage of the maximum plant load by which the boilers are oversized.
   Units: percent

9. Date of Study (DOS): the month and year in which the user is conducting this study.
   Units: mo/year

10. <u>Start of Construction</u>: the month and year in which construction is expected to begin.
    Units: mo/year

11. <u>Beneficial Occup. Date (BOD)</u>: beneficial occupancy date; the month and year in which the plant is to begin operating.
    Units: mo/year

12. <u>Midpoint of Constr. (MPC)</u>: midpoint of construction; the month and year in which the project will be midway between the *Start of Construction* and the *Beneficial Occupancy Date*.
    Units: mo/year

13. <u>Exchange rate</u>: the currency exchange rate between U.S. dollars and Deutsche marks.
    Units: DM/$

14. <u>USER-specified SO2 control capital cost</u>: the capital cost of SO_2 air pollution control equipment.
    Units: $ or DM

15. <u>USER-specified SO2 control O&M cost</u>: the annual operations and maintenance cost for SO_2 air pollution control.
    Units: $/yr or DM/yr

16. <u>USER-specified particulate control capital cost</u>: the capital cost of particulate air pollution control equipment.
    Units: $ or DM

17. <u>USER-specified particulate control O&M cost</u>: the annual operations and maintenance cost for particulate air pollution control.
    Units: $/yr or DM/yr

18. <u>Year in which costs are valid</u>: the year for which USER-specified capital and O&M air pollution control costs are accurate (SO_2 or particulate control).
    Units: year

19. <u>USER-specified retrofit adjustment</u>: the amount by which capital costs are adjusted to reflect the effect of a retrofit. This value may be positive or negative. The retrofit adjustment is expressed in "date of study" dollars (or DM).
    Units: $ or DM

4. ASSUMPTIONS

4.1 Economic Assumptions

All assumptions and methods are consistent with the guidelines stated in the Department of Energy's *Life-Cycle Costing Manual for the Federal Energy Management Program*, Handbook 135. When an LCCID input file is created by HPCALC, HPCALC makes the following assumptions:

1. The study period is 25 years unless the user changes the asset life.

2. Cash flows are automatically discounted at 7 percent.

3. Capital costs occur at the midpoint of construction.

4. When "wood" is selected as the fuel type, its future cost is calculated using the price escalation rates assigned for coal.

5. When "Option 1" is selected as the fuel type, its future cost is calculated using the price escalation rates assigned for residual fuel oil (#6 oil).

To run LCCID using different assumptions, the user must modify the ".LC" file created by LCCID. (See section II-3.4 for a brief description of the ".LC" file, or refer to the LCCID User's Manual.)

4.2 Technical Assumptions

1. For a steam generating plant, the output steam is saturated and has a pressure of 150 psig.

2. For a hot water generating plant, the output hot water has a temperature of 250 deg F.

3. The condensate returned to the plant is 180 deg F, and the make-up water is 60 deg F.

4. The blowdown rate is 5 percent.

5. When ash constitutes less than 1.0 percent of a fuel's weight, there is no particulate control cost.

6. When sulfur constitutes less than 0.5 percent of a fuel's weight, there is no SO_2 control cost.

7. All auxiliary equipment other than those defined under "Boiler Efficiency" (see section III-3.1.2 for definition), are electrically driven.

8. Quicklime is 90 percent pure.

5. HEATLOAD CALCULATIONS

HEATLOAD calculates the total annual power demand for a given facility. This demand is separated into two component loads: the fixed load and the variable load.

5.1 Fixed Load

Fixed loads are those which remain approximately constant throughout the year (e.g., domestic hot water use). The fixed load is computed by summing the fixed loads for each building type.

Variables

Program variables
b = building type (1-12)

1 = Family Housing	7 = Medical/Dental Fac
2 = Barracks, pre-1966	8 = Production/Maint Fac
3 = Barracks, post-1966	9 = Field Houses & Gyms
4 = Barracks, modular	10 = Commissary
5 = Admin/Training Fac	11 = Storage Buildings
6 = Dining Facility	12 = User Defined Bldg

From HEATLOAD file (*.HDA), BUILDING HEAT USE data table
BLDGCONST[**b**] = constant load for building type **b** (Btu/sq ft/day).

USER-specified
BLDGAREA[**b**] = building area for building type **b** (sq ft).

Calculated in this section
TOTBLDGAREA = total facility building area (sq ft).
CONSTLOAD = estimated constant load for the facility (MBtu/hr).

Calculations

TOTBLDGAREA = 0
CONSTLOAD = 0

For **b** = 1 to 12

TOTBLDGAREA = **TOTBLDGAREA** + **BLDGAREA**[**b**]

$$\mathbf{CONSTLOAD} = \mathbf{CONSTLOAD} + \frac{(\mathbf{BLDGCONST}[\mathbf{b}]*\mathbf{BLDGAREA}[\mathbf{b}])}{(24\ \text{hrs/day})*(1{,}000{,}000\ \text{Btu/MBtu})}$$

Next **b**

(Begin section 5.2)

5.2 Variable Load

Variable loads are those which vary throughout the year (e.g., space heating). The variable load is computed by summing the variable loads for each building type to arrive at a facility maximum, minimum, and average variable load.

Variables

Program variables

t = temperature bin (1-21)

1 = 65 to 69 deg F	8 = 30 to 34 deg F	15 = -5 to -1 deg F
2 = 60 to 64 deg F	9 = 25 to 29 deg F	16 = -10 to -6 deg F
3 = 55 to 59 deg F	10 = 20 to 24 deg F	17 = -15 to -11 deg F
4 = 50 to 54 deg F	11 = 15 to 19 deg F	18 = -20 to -16 deg F
5 = 45 to 49 deg F	12 = 10 to 14 deg F	19 = -25 to -21 deg F
6 = 40 to 44 deg F	13 = 5 to 9 deg F	20 = -30 to -26 deg F
7 = 35 to 39 deg F	14 = 0 to 4 deg F	21 = -35 to -31 deg F

b = building type (1-12)

1 = Family Housing	7 = Medical/Dental Fac
2 = Barracks, pre-1966	8 = Production/Maint Fac
3 = Barracks, post-1966	9 = Field Houses & Gyms
4 = Barracks, modular	10 = Commissary
5 = Admin/Training Fac	11 = Storage Buildings
6 = Dining Facility	12 = User Defined Bldg

mo = month of the year (Jan-Dec).
NDM[mo] = number of days in month **mo** (integer).

From HEATLOAD file (*.HDA), CLIMATE data table
HRLYTEMP[mo,t] = number of hours in month **mo** for which the outside air temperature falls within the temperature bin **t** (hrs/month).

From HEATLOAD file (*.HDA), BUILDING HEAT USE data table
BLDGVAR[b] = variable load for building type **b** (Btu/sq ft/day/HDD).

USER-specified
DESTEMP = design temperature for facility (deg F).
BLDGAREA[b] = building area for building type **b** (sq ft).

Calculated in this section
MAXDEGDAY = temperature difference between inside air at 65 deg F and outside air at **DESTEMP** assumed to occur for a 24 hour period (HDD).
AVGBINTEMP[t] = midpoint temperature for temperature bin **t** (deg F).
DEGDAY[t] = temperature difference between inside air at 65 deg F and outside air at **AVGBINTEMP[t]** for temperature bin **t** assumed to occur for a 24 hour period (HDD).
TOTDEGDAY = annual number of heating degree days (HDD/yr).
BLDGLOAD[t,b] = average load for temperature bin **t** and building type **b** (MBtu/hr).
BINLD[t] = average load for temperature bin **t** (MBtu/hr).

AVGLD[mo] = average load for month **mo** (MBtu/month).
ANNLOAD = total annual variable load (MBtu/yr).
MAXLOAD = maximum variable load (MBtu/hr).
MINLOAD = minimum variable load (MBtu/hr).
AVGLOAD = average variable load (MBtu/hr).

Calculations

MAXDEGDAY = (65 deg F) - **DESTEMP**
MAXLOAD = 0
For **b** = 1 to 12

$$\mathbf{MAXLOAD} = \mathbf{MAXLOAD} + \frac{\mathbf{BLDGAREA[b]*BLDGVAR[b]*MAXDEGDAY}}{\text{(24 hrs/day)*(1,000,000 Btu/MBtu)}}$$

Next **b**

TOTDEGDAY = 0
For **mo** = Jan to Dec
    AVGLD[mo] = 0
    For **t** = 2 to 21 (NOTE: **t** = 1 is not a heating temperature bin.)
        BINLD[t] = 0
        AVGBINTEMP[t] = (70-**t***5 + 70-(**t**-1)*5)/2
        DEGDAY[t] = 65.0 - **AVGBINTEMP[t]**
        For **b** = 1 to 12

$$\mathbf{BLDGLOAD[t,b]} = \frac{\mathbf{BLDGAREA[b]*BLDGVAR[b]*DEGDAY[t]}}{\text{(24 hrs/day)*(1,000,000 Btu/MBtu)}}$$

            BINLD[t] = **BINLD[t]** + **BLDGLOAD[t,b]**
        Next **b**
        AVGLD[mo] = **AVGLD[mo]** + **HRLYTEMP[mo,t]*BINLD[t]**

$$\mathbf{TOTDEGDAY} = \mathbf{TOTDEGDAY} + \frac{\mathbf{DEGDAY[t]*HRLYTEMP[mo,t]}}{\text{(24 hrs/day)}*\mathbf{NDM[mo]}}$$

    Next **t**
Next **mo**
MINLOAD = minimum of {**AVGLD[mo]**/(24 hrs/day)/**NDM[mo]**}
    For **mo** = Jan to Dec

ANNLOAD = 0
For **mo** = Jan to Dec
    ANNLOAD = **ANNLOAD** + **AVGLD[mo]**
Next **mo**
AVGLOAD = **ANNLOAD**/(24 hrs/day)/(365 days/yr)

(Begin section 5.3)

5.3 Maximum, Minimum, and Average Design Load

Variables

Program variables
mo = month of the year (Jan-Dec).

From HEATLOAD file (*.HDA), CLIMATE data table
MINTEMP[**mo**] = lowest temperature bin achieved in month **mo** (1-21).

Defined in section 5.1
CONSTLOAD = estimated constant load for the facility (MBtu/hr).

Defined in section 5.2
BINLD[**t**] = average load for temperature bin **t** (MBtu/hr).
AVGLD[**mo**] = average load for month **mo** (MBtu/month).
MAXLOAD = maximum variable load (MBtu/hr).
MINLOAD = minimum variable load (MBtu/hr).
AVGLOAD = average variable load (MBtu/hr).

Calculated in this section
BLDGMAX = maximum design load (MBtu/hr).
BLDGMIN = minimum design load (MBtu/hr).
BLDGAVG = average design load (MBtu/hr).

NOTE: **BLDGMAX**, **BLDGMIN**, & **BLDGAVG** are used in HPCALC.

MAXIMUM[**mo**] = maximum load for month **mo** (MBtu/hr).
AVERAGE[**mo**] = average load for month **mo** (MBtu/hr).

Calculations

For **mo** = Jan to Dec

MAXIMUM[**mo**] = **BINLD**[**MINTEMP**[**mo**]] + **CONSTLOAD**

AVERAGE[**mo**] = (**AVGLD**[**mo**]/(24 hrs/day)/**NDM**[**mo**]) + **CONSTLOAD**

Next **mo**

BLDGMAX = **CONSTLOAD** + **MAXLOAD**

BLDGMIN = **CONSTLOAD** + **MINLOAD**

BLDGAVG = **CONSTLOAD** + **AVGLOAD**

5.4 HEATLOAD Report

Figure III-1 identifies the origins of the data contained in a HEATLOAD report. Boldface type indicates variables defined in sections III-5.1 through III-5.3.

```
****************************************************************************
**                            H E A T L O A D                             **
**                          Energy Usage Report                           **
**                                                                        **
**  Date  :  mm/dd/year                     Climate Region: <region name> **
**  Title :  <title>                                                      **
**  File  : <heatload>.HDA                                                **
****************************************************************************
                                        |
                                        |
                                        |
Month      Maximum         Average      |  Building               Building
          (MBtu/hr)       (MBtu/hr)     |  Type                   Area sq.ft.
-----     ---------       ---------     |  --------               -----------
                                        |
Jan     MAXIMUM[Jan]    AVERAGE[Jan]    |  Family Housing......  BLDGAREA[1]
Feb     MAXIMUM[Feb]    AVERAGE[Feb]    |  Barracks, pre-1966..  BLDGAREA[2]
Mar     MAXIMUM[Mar]    AVERAGE[Mar]    |  Barracks, post-1966.  BLDGAREA[3]
Apr     MAXIMUM[Apr]    AVERAGE[Apr]    |  Barracks, modular...  BLDGAREA[4]
May     MAXIMUM[May]    AVERAGE[May]    |  Admin/Training Facil  BLDGAREA[5]
Jun     MAXIMUM[Jun]    AVERAGE[Jun]    |  Dining Facility.....  BLDGAREA[6]
Jul     MAXIMUM[Jul]    AVERAGE[Jul]    |  Medical/Dental Facil  BLDGAREA[7]
Aug     MAXIMUM[Aug]    AVERAGE[Aug]    |  Production/Maint Fac  BLDGAREA[8]
Sep     MAXIMUM[Sep]    AVERAGE[Sep]    |  Field Houses & Gyms.  BLDGAREA[9]
Oct     MAXIMUM[Oct]    AVERAGE[Oct]    |  Commissary..........  BLDGAREA[10]
Nov     MAXIMUM[Nov]    AVERAGE[Nov]    |  Storage Buildings...  BLDGAREA[11]
Dec     MAXIMUM[Dec]    AVERAGE[Dec]    |  User Defined Bldg...  BLDGAREA[12]
                                        |
----------------------------------------------------------------------------


Parasitic Load   =             CONSTLOAD            Design Loads (MBtu/hr)
Total Building Area =        TOTBLDGAREA            ----------------------
Heating Degree Days =          TOTDEGDAY              Maximum     BLDGMAX
-------------------------------------------------     Minimum     BLDGMIN
Total Load     =  ANNLOAD + CONSTLOAD*(8,760 hrs/yr)  Average     BLDGAVG


Design Maximum Load at    DESTEMP.
```

Figure III-1. The origins of HEATLOAD report entries.

6. HPCALC CALCULATIONS

6.1 Determining Plant Design Load

The user can enter estimated plant loads, or use HEATLOAD data to estimate plant loads.

- Begin section III-6.1.1 for USER-estimated loads.
- Begin section III-6.1.2 for HEATLOAD-estimated loads.

6.1.1 Calculations for USER-estimated loads

Variables

Program variables
mo = month of the year (Jan-Dec).
NDM[**mo**] = number of days in month **mo** (integer).

USER-specified
MAXLOAD = estimated maximum plant load (MBtu/hr).
MINLOAD = estimated minimum plant load (MBtu/hr).
AVGLOAD = estimated average plant load (MBtu/hr).

NOTE: **MAXLOAD**, **MINLOAD**, & **AVGLOAD** include "no-load load" and "process load."

Calculated in this section
AVGLOAD[mo] = average load for month **mo** (MBtu/month).
ANNLOAD = total annual load (MBtu/yr).

Calculations

For **mo** = Jan to Dec

AVGLOAD[**mo**] = **AVGLOAD*****NDM**[**mo**]*(24 hrs/day)

Next **mo**

ANNLOAD = **AVGLOAD***(24 hrs/day)*(365 days/yr)

(Begin section III-6.2)

6.1.2 Calculations for HEATLOAD-estimated loads

Variables

<u>Program variables</u>
mo = month of the year (Jan-Dec).
NDM[mo] = number of days in month **mo** (integer).

<u>USER-specified</u>
PROL = process load (MBtu/hr).
NOLL = no-load load as a percentage of maximum plant load (%). Maximum plant load includes the "maximum design load", the "process load", and the "no-load load."

<u>From HEATLOAD data file (*.HDA), defined in section III-5.3</u>
BLDGMAX = maximum design load (MBtu/hr).
BLDGMIN = minimum design load (MBtu/hr).
BLDGAVG = average design load (MBtu/hr).

NOTE: **BLDGMAX, BLDGMIN,** & **BLDGAVG** do not include "no-load load" and "process load."

<u>Calculated in this section</u>
NLL = no-load load (MBtu/hr).
MAXLOAD = estimated maximum plant load (MBtu/hr).
MINLOAD = estimated minimum plant load (MBtu/hr).
AVGLOAD = estimated average plant load (MBtu/hr).
AVGLOAD[mo] = average load for month **mo** (MBtu/month).
ANNLOAD = total annual load (MBtu/yr).

NOTE: **MAXLOAD, MINLOAD,** & **AVGLOAD** include "no-load load" and "process load."

Calculations

NLL = (**BLDGMAX** + **PROL**)/(100%/**NOLL** - 1)

MAXLOAD = **BLDGMAX** + **PROL** + **NLL**
MINLOAD = **BLDGMIN** + **PROL** + **NLL**
AVGLOAD = **BLDGAVG** + **PROL** + **NLL**

For **mo** = Jan to Dec

AVGLOAD[mo] = **AVGLOAD*NDM[mo]***(24 hrs/day)

Next **mo**

ANNLOAD = **AVGLOAD***(24 hrs/day)*(365 days/yr)

(Begin section III-6.2)

6.2 Steam or Hot Water Boiler System

The user must choose between a steam or hot water boiler system.

- Begin section III-6.2.1 for a hot water boiler system.
- Begin section III-6.2.2 for a steam boiler system.

6.2.1 Hot water boiler system

No calculations

(Begin section III-6.3)

6.2.2 Steam boiler system

Variables

Program constants
HOUT = 1,195.6 Btu/lbm = enthalpy of 150 psig saturated steam.
HCOND = 148 Btu/lbm = enthalpy of condensate returned at 180 deg F
HMU = 28 Btu/lbm = enthalpy of make-up water at 60 deg F.

USER-specified
PCTCOND = percentage of steam returned as condensate (%).

Defined in section III-6.1
MAXLOAD = estimated maximum plant load (MBtu/hr).
ANNLOAD = total annual load (MBtu/yr).

Calculated in this section
COND = fraction of steam returned as condensate (scalar).
BOILERSTEAM = steam flow at boiler capacity (lbm/hr).
ANNUALSTEAM = total annual steam flow (lbm/yr).

Calculations

$$\mathbf{COND} = \mathbf{PCTCOND}/100\%$$

$$\mathbf{BOILERSTEAM} = \frac{\mathbf{MAXLOAD}*(1{,}000{,}000 \text{ Btu/MBtu})}{\mathbf{HOUT} - (\mathbf{COND}*\mathbf{HCOND}) - (1 - \mathbf{COND})*\mathbf{HMU}}$$

$$\mathbf{ANNUALSTEAM} = \frac{\mathbf{ANNLOAD}*(1{,}000{,}000 \text{ Btu/MBtu})}{\mathbf{HOUT} - (\mathbf{COND}*\mathbf{HCOND}) - (1 - \mathbf{COND})*\mathbf{HMU}}$$

(Begin section III-6.3)

6.3 Boiler Configuration

The user must choose between an "extra boiler" or an "oversized boiler" backup system. According to Army Engineer Technical Letter No. 1110-3-256, for a plant with one boiler off line, the remaining boilers must be capable of carrying not less than 65 percent, nor more than 75 percent, of the maximum winter design load.

- Begin section III-6.3.1 for an "extra boiler" backup system.
- Begin section III-6.3.2 for an "oversized boiler" backup system.

6.3.1 "Extra boiler" backup system

In cases where the total number of boilers is 3 or 4, two configurations are possible: Configuration A - all boilers regular size, and Configuration B - one small boiler and the rest regular size. These configurations are checked in section III-6.4 to determine which technologies can support them. If each configuration can be satisfied by at least one technology, then the user must choose a configuration with which to continue the analysis.

Variables

From HPDATA file (*.CDA), MISCELLANEOUS PARAMETERS data table
COALTURNDWN = coal turn down ratio (scalar). The turn down ratio for coal is used because it is typically more restrictive than that for oil, natural gas, or wood.

USER-specified
NUMBOIL = number of boilers (1-3), not including backup boiler.

Defined in section III-6.1
MAXLOAD = estimated maximum plant load (MBtu/hr).
MINLOAD = estimated minimum plant load (MBtu/hr).

Calculated in this section
BACKUPFAC = oversizing as a factor of maximum plant load (scalar).
NUMBOILERS = number of boilers including backup boiler (1-4).
REGBOILCAP = design capacity for a regular sized boiler (MBtu/hr).
SMLBOILCAP = design capacity for a small sized boiler (MBtu/hr).
TOTPLANTCAP = total plant capacity (MBtu/hr).

Calculations

BACKUPFAC = 1

NUMBOILERS = **NUMBOIL** + (1 backup boiler)

DO ONE OF THE FOLLOWING

For **NUMBOILERS** = 2

case A: 2 regular boilers
REGBOILCAP = **MAXLOAD**
TOTPLANTCAP = **REGBOILCAP***(2 boilers)

(Begin section III-6.4)

For **NUMBOILERS** = 3

case A: 3 regular boilers
REGBOILCAP = **MAXLOAD**/(2 boilers)
TOTPLANTCAP = **REGBOILCAP***(3 boilers)

case B: 2 regular boilers and 1 small boiler
SMLBOILCAP = **MINLOAD*MAXTURNDWN**
REGBOILCAP = **MAXLOAD** - **SMLBOILCAP**
TOTPLANTCAP = **REGBOILCAP***(2 boilers) + **SMLBOILCAP***(1 boiler)

(Begin section III-6.4)

For **NUMBOILERS** = 4

case A: 4 regular boilers
REGBOILCAP = **MAXLOAD**/(3 boilers)
TOTPLANTCAP = **REGBOILCAP***(4 boilers)

case B: 3 regular boilers and 1 small boiler
SMLBOILCAP = **MINLOAD*MAXTURNDWN**
REGBOILCAP = (**MAXLOAD** - **SMLBOILCAP**)/(2 boilers)
TOTPLANTCAP = **REGBOILCAP***(3 boilers) + **SMLBOILCAP***(1 boiler)

(Begin section III-6.4)

6.3.2 "Oversized boiler" backup system

In cases where the total number of boilers is 2 or 3, two configurations are possible: Configuration A - all boilers regular size, and Configuration B - one small boiler and the rest regular size. These configurations are checked in section III-6.4 to determine which technologies can support them. If each configuration can be satisfied by at least one technology, then the user must choose a configuration with which to continue the analysis.

Variables

From HPDATA file (*.CDA), MISCELLANEOUS PARAMETERS data table

COALTURNDWN = coal turn down ratio (scalar). The turn down ratio for coal is used because it is typically more restrictive than that for oil, natural gas, or wood.

USER-specified

NUMBOIL = number of boilers (1-3), not including backup boiler.
PCTBACKUP = oversizing as a percentage of maximum plant load (%).

Defined in section III-6.1

MAXLOAD = estimated maximum plant load (MBtu/hr).
MINLOAD = estimated minimum plant load (MBtu/hr).

Calculated in this section

BACKUPFAC = oversizing as a factor of maximum plant load (scalar).
NUMBOILERS = number of boilers including backup boiler (1-4).
REGBOILCAP = design capacity for a regular sized boiler (MBtu/hr).
SMLBOILCAP = design capacity for a small sized boiler (MBtu/hr).
TOTPLANTCAP = total plant capacity (MBtu/hr).

Calculations

BACKUPFAC = 1 + **PCTBACKUP**/100%

NUMBOILERS = **NUMBOIL**

DO ONE OF THE FOLLOWING

For **NUMBOILERS** = 1

case A: 1 regular boiler
REGBOILCAP = **MAXLOAD***__BACKUPFAC__
TOTPLANTCAP = **REGBOILCAP***(1 boilers)

(Begin section III-6.4)

For **NUMBOILERS** = 2

case A: 2 regular boilers
REGBOILCAP = (**MAXLOAD***__BACKUPFAC__)/(2 boilers)
TOTPLANTCAP = **REGBOILCAP***(2 boilers)

case B: 1 regular boiler and 1 small boiler
SMLBOILCAP = **MINLOAD***__MAXTURNDWN__
REGBOILCAP = (**MAXLOAD***__BACKUPFAC__) - **SMLBOILCAP**
TOTPLANTCAP = **REGBOILCAP***(1 boilers) + **SMLBOILCAP***(1 boiler)

(Begin section III-6.4)

For **NUMBOILERS** = 3

case A: 3 regular boilers
REGBOILCAP = (**MAXLOAD***__BACKUPFAC__)/(3 boilers)
TOTPLANTCAP = **REGBOILCAP***(3 boilers)

case B: 2 regular boilers and 1 small boiler
SMLBOILCAP = **MINLOAD***__MAXTURNDWN__
REGBOILCAP = ((**MAXLOAD***__BACKUPFAC__) - **SMLBOILCAP**)/(2 boilers)
TOTPLANTCAP = **REGBOILCAP***(2 boilers) + **SMLBOILCAP***(1 boiler)

(Begin section III-6.4)

6.4 Qualified Technologies

Each technology type must be checked to determine if it can support the specified boiler configuration (as defined by the number of boilers and the type of backup system).

If two boiler configurations are possible (as determined in section III-6.3) and a given technology can support both of them (as determined in this section), then the user must choose one configuration. The final listing of qualified technologies includes only those that qualify under the chosen configuration.

Variables

<u>Program variables</u>

tt = technology type

	Nat Gas ft:w	No ˆ Oil ft:w
Coal-Sto ft:s	Nat Gas ft:s	No 2 Oil ft:s
Coal-Sto wt:s	Nat Gas wt:s	No 2 Oil wt:s
No 6 Oil ft:s	Gas/2Oil ft:w	2Oil/Gas ft:w
No 6 Oil wt:s	Gas/2Oil ft:s	2Oil/Gas ft:s
Wood wt:s	Gas/2Oil wt:s	2Oil/Gas wt:s

Where ft:w indicates FireTube:Water,
ft:s indicates FireTube:Steam, and
wt:s indicates WaterTube:Steam.

<u>From HPDATA file (*.CDA), TECHNOLOGY TYPES data table</u>

MINBOILER[tt] = minimum boiler size available for technology type **tt** (MBtu/hr).

MAXBOILER[tt] = maximum boiler size available for technology type **tt** (MBtu/hr).

FUELTYPE[tt] = coal, oil (#2 or #6), natural gas, or wood = fuel type specified for technology type **tt**

<u>From HPDATA file (*.CDA), MISCELLANEOUS PARAMETERS data table</u>

COALTURNDWN = coal turn down ratio (scalar).
OILTURNDWN = oil turn down ratio (scalar).
GASTURNDWN = gas turn down ratio (scalar).
WOODTURNDWN = wood turn down ratio (scalar).

<u>Defined in section III-6.1</u>

MAXLOAD = estimated maximum plant load (MBtu/hr).
MINLOAD = estimated minimum plant load (MBtu/hr).

<u>Defined in section III-6.3</u>

NUMBOIL = number of boilers (1-3), not including backup boiler.
BACKUPFAC = oversizing as a factor of maximum plant load (scalar).
REGBOILCAP = design capacity for a regular sized boiler (MBtu/hr).
SMLBOILCAP = design capacity for a small sized boiler (MBtu/hr).

<u>Defined in this section</u>

qt = qualified technology types for the chosen configuration.

Calculations

For each technology type, **tt**, if all of the following logical arguments (that apply) are TRUE, then the technology can support the specified boiler configuration.

For "case A" and "case B" configurations, do the following:

- **MINBOILER**[**tt**] ≤ **REGBOILCAP** ≤ **MAXBOILER**[**tt**]

For "case B" configurations only (1 small boiler, the rest regular size), do the following:

- **SMLBOILCAP** < **REGBOILCAP**

- **MINBOILER**[**tt**] ≤ **SMLBOILCAP** ≤ **MAXBOILER**[**tt**]

For "case A" configurations only (all boilers regular size), do the following:

- If **FUELTYPE**[**tt**] = coal, then

  (**MAXLOAD*BACKUPFAC/NUMBOIL**)/**MINLOAD** ≤ **COALTURNDWN**

- If **FUELTYPE**[**tt**] = oil or option 1, then

  (**MAXLOAD*BACKUPFAC/NUMBOIL**)/**MINLOAD** ≤ **OILTURNDWN**

- If **FUELTYPE**[**tt**] = gas, then

  (**MAXLOAD*BACKUPFAC/NUMBOIL**)/**MINLOAD** ≤ **GASTURNDWN**

- If **FUELTYPE**[**tt**] = wood, then

  (**MAXLOAD*BACKUPFAC/NUMBOIL**)/**MINLOAD** ≤ **WOODTURNDWN**

(Begin section III-6.5)

6.5 Availability

Availability represents the percentage of time that a given plant configuration can be expected to satisfy the average load throughout the year. In other words, there is usually a small chance that a plant will not meet its demand due to outages or repairs. Availability is the probability that the combination of boilers in operation at any given time is sufficient to satisfy the average plant load. Availability is the sum of the probabilities determined for each combination of working boilers (i.e., boiler combinations that satisfy the average plant load).

Below is a listing of the formulas used.

For a multiple boiler heating plant, the probability (P) for each boiler to be operational is:

P = 1.0 - (forced outage rate).

For a one boiler heating plant, the probability (P) for the boiler (and hence, the entire plant) to be operational is:

P = 1.0 - (forced outage rate) - (planned outage rate).

Let N = number of boilers including backup boiler (1-4),
A = number of regular boilers (1-3),
B = number of small boilers (0-1), and

NOTE: $\binom{u}{x} = (u \text{ "Choose" } x) = u!/((u-x)!*x!)$

For a "case A" configuration (all boilers regular size), the probability for a certain combination of boilers working is:

$$\text{Probability} = \binom{N}{A} * P^{A}(1-P)^{N-A}$$

For a "case B" configuration (1 small boiler, the rest regular size), the probability for a certain combination of boilers working is:

$$\text{Probability} = \binom{N-1}{A} * P^{A}P^{B}(1-P)^{1-B}(1-P)^{N-1-A}$$

Variables

Defined in section III-6.4
qt = qualified technology types.

Program variables
mo = month of the year (Jan-Dec).
NDM[**mo**] = number of days in month **mo** (integer).

From HPDATA file (*.CDA), TECHNOLOGY TYPES data table
FORCEDOUT[**qt**] = the percentage of time a boiler is out of operation due to unforeseen events for technology type **qt** (%).
PLANNEDOUT[**qt**] = the percentage of time a boiler is out of operation due to scheduled events for technology type **qt** (%).

Defined in section III-6.1
AVGLOAD[**mo**] = average load for month **mo** (MBtu/month).

Defined in section III-6.3
NUMBOILERS = number of boilers including backup boiler (1-4).
REGBOILCAP = design capacity for a regular sized boiler (MBtu/hr).
SMLBOILCAP = design capacity for a small sized boiler (MBtu/hr).

Calculated in this section
AVAIL[**qt**] = availability: the sum of probabilities for a certain combination of boilers working for technology type **qt** (scalar).
P = probability for one boiler to be operational (scalar).
PLANTCAP = plant capacity based on boilers in operation (MBtu/hr).

Calculations

The user should begin at the section corresponding to the correct boiler configuration.

6.5.1 One regular boiler

For each qualified technology, **qt**, do the following.

P = 1.0 - (**FORCEDOUT**[**qt**] + **PLANNEDOUT**[**qt**])/100%

AVAIL[**qt**] = **P**

(Begin section III-6.6)

6.5.2 One regular boiler and one small boiler

Boilers	Probability
B	P(1-P)
A	P(1-P)
A + B	P^2

For each qualified technology, **qt**, do the following.

```
AVAIL[qt] = 0.0
P = 1.0 - FORCEDOUT[qt]/100%

PLANTCAP = SMLBOILCAP
For mo = Jan to Dec
      If PLANTCAP > AVGLOAD[mo]/(NDM[mo]*(24 hrs/day))
            AVAIL[qt] = AVAIL[qt] + NDM[mo]/(365 days/yr)*P*(1.0 - P)
Next mo

PLANTCAP = REGBOILCAP
For mo = Jan to Dec
      If PLANTCAP > AVGLOAD[mo]/(NDM[mo]*(24 hrs/day))
            AVAIL[qt] = AVAIL[qt] + NDM[mo]/(365 days/yr)*P*(1.0 - P)
Next mo

PLANTCAP = SMLBOILCAP + REGBOILCAP
For mo = Jan to Dec
      If PLANTCAP > AVGLOAD[mo]/(NDM[mo]*(24 hrs/day))
            AVAIL[qt] = AVAIL[qt] + NDM[mo]/(365 days/yr)*P^2
Next mo
```

(Begin section III-6.6)

6.5.3 Two regular boilers

Boilers	Probability
A	2P(1-P)
2A	P^2

For each qualified technology, **qt**, do the following.

```
AVAIL[qt] = 0.0
P = 1.0 - FORCEDOUT[qt]/100%

PLANTCAP = REGBOILCAP*(1 boiler)
For mo = Jan to Dec
      If PLANTCAP > AVGLOAD[mo]/(NDM[mo]*(24 hrs/day))
            AVAIL[qt] = AVAIL[qt] + NDM[mo]/(365 days/yr)*2*P*(1.0 - P)
Next mo

PLANTCAP = REGBOILCAP*(2 boilers)
For mo = Jan to Dec
      If PLANTCAP > AVGLOAD[mo]/(NDM[mo]*(24 hrs/day))
            AVAIL[qt] = AVAIL[qt] + NDM[mo]/(365 days/yr)*P^2
Next mo
```

(Begin section III-6.6)

6.5.4 Two regular boilers and one small boiler

Boilers	Probability
B	P(1-P)^2
A	2P(1-P)^2
A + B	2P^2(1-P)
2A	P^2(1-P)
2A + B	P^3

For each qualified technology, **qt**, do the following.

```
AVAIL[qt] = 0.0
P = 1.0 - FORCEDOUT[qt]/100%

PLANTCAP = SMLBOILCAP
For mo = Jan to Dec
      If PLANTCAP > AVGLOAD[mo]/(NDM[mo]*(24 hrs/day))
            AVAIL[qt] = AVAIL[qt] + NDM[mo]/(365 days/yr)*P*(1.0 - P)^2
Next mo

PLANTCAP = REGBOILCAP*(1 boiler)
For mo = Jan to Dec
      If PLANTCAP > AVGLOAD[mo]/(NDM[mo]*(24 hrs/day))
            AVAIL[qt] = AVAIL[qt] + NDM[mo]/(365 days/yr)*2*P*(1.0 - P)^2
Next mo

PLANTCAP = SMLBOILCAP + REGBOILCAP*(1 boiler)
For mo = Jan to Dec
      If PLANTCAP > AVGLOAD[mo]/(NDM[mo]*(24 hrs/day))
            AVAIL[qt] = AVAIL[qt] + NDM[mo]/(365 days/yr)*2*P^2*(1.0 - P)
Next mo

PLANTCAP = REGBOILCAP*(2 boilers)
For mo = Jan to Dec
      If PLANTCAP > AVGLOAD[mo]/(NDM[mo]*(24 hrs/day))
            AVAIL[qt] = AVAIL[qt] + NDM[mo]/(365 days/yr)*P^2*(1.0 - P)
Next mo

PLANTCAP = SMLBOILCAP + REGBOILCAP*(2 boilers)
For mo = Jan to Dec
      If PLANTCAP > AVGLOAD[mo]/(NDM[mo]*(24 hrs/day))
            AVAIL[qt] = AVAIL[qt] + NDM[mo]/(365 days/yr)*P^3
Next mo
```

(Begin section III-6.6)

6.5.5 Three regular boilers

Boilers	Probability
A	$3P(1-P)^2$
2A	$3P^2(1-P)$
3A	P^3

For each qualified technology, **qt**, do the following.

```
AVAIL[qt] = 0.0
P = 1.0 - FORCEDOUT[qt]/100%

PLANTCAP = REGBOILCAP*(1 boiler)
For mo = Jan to Dec
      If PLANTCAP > AVGLOAD[mo]/(NDM[mo]*(24 hrs/day))
            AVAIL[qt] = AVAIL[qt] + NDM[mo]/(365 days/yr)*3*P*(1.0 - P)^2
Next mo

PLANTCAP = REGBOILCAP*(2 boilers)
For mo = Jan to Dec
      If PLANTCAP > AVGLOAD[mo]/(NDM[mo]*(24 hrs/day))
            AVAIL[qt] = AVAIL[qt] + NDM[mo]/(365 days/yr)*3*P^2*(1.0 - P)
Next mo

PLANTCAP = REGBOILCAP*(3 boilers)
For mo = Jan to Dec
      If PLANTCAP > AVGLOAD[mo]/(NDM[mo]*(24 hrs/day))
            AVAIL[qt] = AVAIL[qt] + NDM[mo]/(365 days/yr)*P^3
Next mo
```

(Begin section III-6.6)

6.5.6 Three regular boilers and one small boiler

Boilers	Probability
B	$P(1-P)^3$
A	$3P(1-P)^3$
A + B	$3P^2(1-P)^2$
2A	$3P^2(1-P)^2$
2A + B	$3P^3(1-P)$
3A	$P^3(1-P)$
3A + B	P^4

For each qualified technology, **qt**, do the following.

```
AVAIL[qt] = 0.0
P = 1.0 - FORCEDOUT[qt]/100%

PLANTCAP = SMLBOILCAP
For mo = Jan to Dec
      If PLANTCAP > AVGLOAD[mo]/(NDM[mo]*(24 hrs/day))
            AVAIL[qt] = AVAIL[qt] + NDM[mo]/(365 days/yr)*P*(1.0 - P)^3
Next mo

PLANTCAP = REGBOILCAP*(1 boiler)
For mo = Jan to Dec
      If PLANTCAP > AVGLOAD[mo]/(NDM[mo]*(24 hrs/day))
            AVAIL[qt] = AVAIL[qt] + NDM[mo]/(365 days/yr)*3*P*(1.0 - P)^3
Next mo

PLANTCAP = SMLBOILCAP + REGBOILCAP*(1 boiler)
For mo = Jan to Dec
      If PLANTCAP > AVGLOAD[mo]/(NDM[mo]*(24 hrs/day))
            AVAIL[qt] = AVAIL[qt] + NDM[mo]/(365 days/yr)*3*P^2*(1.0 - P)^2
Next mo

PLANTCAP = REGBOILCAP*(2 boilers)
For mo = Jan to Dec
      If PLANTCAP > AVGLOAD[mo]/(NDM[mo]*(24 hrs/day))
            AVAIL[qt] = AVAIL[qt] + NDM[mo]/(365 days/yr)*3*P^2*(1.0 - P)^2
Next mo

PLANTCAP = SMLBOILCAP + REGBOILCAP*(2 boilers)
For mo = Jan to Dec
      If PLANTCAP > AVGLOAD[mo]/(NDM[mo]*(24 hrs/day))
            AVAIL[qt] = AVAIL[qt] + NDM[mo]/(365 days/yr)*3*P^3*(1.0 - P)
Next mo

PLANTCAP = REGBOILCAP*(3 boilers)
For mo = Jan to Dec
      If PLANTCAP > AVGLOAD[mo]/(NDM[mo]*(24 hrs/day))
            AVAIL[qt] = AVAIL[qt] + NDM[mo]/(365 days/yr)*P^3*(1.0 - P)
Next mo

PLANTCAP = SMLBOILCAP + REGBOILCAP*(3 boilers)
For mo = Jan to Dec
      If PLANTCAP > AVGLOAD[mo]/(NDM[mo]*(24 hrs/day))
            AVAIL[qt] = AVAIL[qt] + NDM[mo]/(365 days/yr)*P^4
Next mo
```

(Begin section III-6.6)

6.5.7 Four regular boilers

Boilers	Probability
A	$4P(1-P)^3$
2A	$6P^2(1-P)^2$
3A	$4P^3(1-P)$
4A	P^4

For each qualified technology, **qt**, do the following.

```
AVAIL[qt] = 0.0
P = 1.0 - FORCEDOUT[qt]/100%

PLANTCAP = REGBOILCAP*(1 boiler)
For mo = Jan to Dec
      If PLANTCAP > AVGLOAD[mo]/(NDM[mo]*(24 hrs/day))
            AVAIL[qt] = AVAIL[qt] + NDM[mo]/(365 days/yr)*4*P*(1.0 - P)^3
Next mo

PLANTCAP = REGBOILCAP*(2 boilers)
For mo = Jan to Dec
      If PLANTCAP > AVGLOAD[mo]/(NDM[mo]*(24 hrs/day))
           AVAIL[qt] = AVAIL[qt] + NDM[mo]/(365 days/yr)*6*P^2*(1.0 - P)^2
Next mo

PLANTCAP = REGBOILCAP*(3 boilers)
For mo = Jan to Dec
      If PLANTCAP > AVGLOAD[mo]/(NDM[mo]*(24 hrs/day))
            AVAIL[qt] = AVAIL[qt] + NDM[mo]/(365 days/yr)*4*P^3*(1.0 - P'
Next mo

PLANTCAP = REGBOILCAP*(4 boilers)
For mo = Jan to Dec
      If PLANTCAP > AVGLOAD[mo]/(NDM[mo]*(24 hrs/day))
            AVAIL[qt] = AVAIL[qt] + NDM[mo]/(365 days/yr)*P^4
Next mo
```

(Begin section III-6.6)

6.6 Capital Cost Escalation

Variables

From HPDATA file (*.CDA), CAPITAL COST INDICES data table
REFYR = reference year of cost data (year).
CCINDEX[**REFYR**] = capital cost index for the year **REFYR** (scalar).
CCINDEX[**STUDYR**] = capital cost index for the year **STUDYR** (scalar).

USER-specified
STUDYR = year of study (year).

Calculated in this section
CCESCAL = capital cost escalation factor (scalar).

Calculations

CCESCAL = **CCINDEX**[**STUDYR**]/**CCINDEX**[**REFYR**]

(Begin section III-6.7)

6.7 Purchased Equipment Capital Cost

Variables

Program variables
x = number of boilers of the same size for a given plant configuration (integer).

Defined in section III-6.4
qt = qualified technology types.

From HPDATA file (*.CDA), CAPITAL COSTS data table
A[**qt**] = equipment cost coefficient for technology type **qt** ($1,000/MBtu/hr).
B[**qt**] = equipment cost exponent for technology type **qt** (scalar).

Defined in section III-6.3
NUMBOILERS = number of boilers including backup boiler (1-4).
REGBOILCAP = design capacity for a regular sized boiler (MBtu/hr).
SMLBOILCAP = design capacity for a small sized boiler (MBtu/hr).

Defined in section III-6.6
CCESCAL = capital cost escalation factor (scalar).

Calculated in this section
PEC[**qt**] = purchased equipment cost for technology type **qt** ($).
DISCOUNT = factor to reduce boiler prices when purchasing multiple units of the same size (scalar).

Calculations

The user should begin at the section corresponding to the correct boiler configuration. Note that the purchased equipment cost is discounted for boiler configurations containing two or more regular sized boilers.

6.7.1 One regular boiler

For each qualified technology, **qt**, do the following.

PEC[**qt**] = (**A**[**qt**]*(1,000)***REGBOILCAP**$^{\mathbf{B}[\mathbf{qt}]}$)***CCESCAL**

(Begin section III-6.8)

6.7.2 One regular boiler and one small boiler

For each qualified technology, **qt**, do the following.

PEC[**qt**] = (**A**[**qt**]*(1,000)***SMLBOILCAP**$^{\mathbf{B}[\mathbf{qt}]}$)***CCESCAL** +

(**A**[**qt**]*(1,000)***REGBOILCAP**$^{\mathbf{B}[\mathbf{qt}]}$)***CCESCAL**

(Begin section III-6.8)

6.7.3 Two regular boilers

x = 2
DISCOUNT = 0.98$^{\mathbf{x}}$ = 0.96

For each qualified technology, **qt**, do the following.

PEC[**qt**] = (**A**[**qt**]*(1,000)***REGBOILCAP**$^{\mathbf{B}[\mathbf{qt}]}$)*

(2 boilers)***CCESCAL***DISCOUNT**

(Begin section III-6.8)

6.7.4 Two regular boilers and one small boiler

x = 2
DISCOUNT = 0.98$^{\mathbf{x}}$ = 0.96

For each qualified technology, **qt**, do the following.

PEC[**qt**] = (**A**[**qt**]*(1,000)***SMLBOILCAP**$^{\mathbf{B}[\mathbf{qt}]}$)***CCESCAL** +

(**A**[**qt**]*(1,000)***REGBOILCAP**$^{\mathbf{B}[\mathbf{qt}]}$)*

(2 boilers)***CCESCAL***DISCOUNT**

(Begin section III-6.8)

6.7.5 Three regular boilers

x = 3
DISCOUNT = 0.98^{x} = 0.94

For each qualified technology, **qt**, do the following.

PEC[**qt**] = (**A**[**qt**]*(1,000)***REGBOILCAP**$^{B[qt]}$)*

(3 boilers)***CCESCAL*****DISCOUNT**

(Begin section III-6.8)

6.7.6 Three regular boilers and one small boiler

x = 3
DISCOUNT = 0.98^{x} = 0.94

For each qualified technology, **qt**, do the following.

PEC[**qt**] = (**A**[**qt**]*(1,000)***SMLBOILCAP**$^{B[qt]}$)***CCESCAL** +

(**A**[**qt**]*(1,000)***REGBOILCAP**$^{B[qt]}$)*

(3 boilers)***CCESCAL*****DISCOUNT**

(Begin section III-6.8)

6.7.7 Four regular boilers

x = 4
DISCOUNT = 0.98^{x} = 0.92

For each qualified technology, **qt**, do the following.

PEC[**qt**] = (**A**[**qt**]*(1,000)***REGBOILCAP**$^{B[qt]}$)*

(4 boilers)***CCESCAL*****DISCOUNT**

(Begin section III-6.8)

6.8 Balance of Plant Cost

Variables

Defined in section III-6.4
qt = qualified technology types.

From HPDATA file (*.CDA), CAPITAL COSTS data table
PCTBOP[qt] = balance of plant cost as a percentage of puchased equipment cost for technology type **qt** (%).

Defined in section III-6.7
PEC[qt] = purchased equipment cost for technology type **qt** ($).

Calculated in this section
BOP[qt] = balance of plant cost for technology type **qt** ($).

Calculations

For each qualified technology, **qt**, do the following.

BOP[qt] = **PEC[qt]*PCTBOP[qt]**/100%

(Begin section III-6.9)

6.9 Retrofit Adjustment

- Begin section III-6.9.1 if this is not a retrofit project.
- Begin section III-6.9.2 to use the HPDATA retrofit adjustment.
- Begin section III-6.9.3 to use the USER-specified retrofit adjustment.

6.9.1 Not a retrofit project

Variables

Defined in section III-6.4
qt = qualified technology types.

Calculated in this section
RET[**qt**] = retrofit adjustment for technology type **qt** ($).

Calculations

For each qualified technology, **qt**, do the following.

RET[**qt**] = $0

(Begin section III-6.10)

6.9.2 HPDATA retrofit adjustment

Variables

Defined in section III-6.4
qt = qualified technology types.

From HPDATA file (*.CDA), CAPITAL COSTS data table
PCTRET[**qt**] = retrofit adjustment as a percentage of **BOP**[**qt**] for technology type **qt** (%).

Defined in section III-6.7
PEC[**qt**] = purchased equipment cost for technology type **qt** ($).

Defined in section III-6.8
BOP[**qt**] = balance of plant cost for technology type **qt** ($).

Calculated in this section
RET[**qt**] = retrofit adjustment for technology type **qt** ($).

Calculations

For each qualified technology, **qt**, do the following.

RET[**qt**] = **BOP**[**qt**]***PCTRET**[**qt**]/100% - **BOP**[**qt**]

(Begin section III-6.10)

6.9.3 User-specified retrofit adjustment

Variables

Defined in section III-6.4
qt = qualified technology types.

USER-specified
USERRET[**qt**] = user supplied retrofit adjustment for technology type **qt** in "date of study" dollars ($).

Calculated in this section
RET[**qt**] = retrofit adjustment for technology type **qt** ($).

Calculations

For each qualified technology, **qt**, do the following.

RET[**qt**] = **USERRET**[**qt**]

(Begin section III-6.10)

6.10 SO_2 Air Pollution Control Capital Cost

- Begin section III-6.10.1 if there is no SO_2 control.
- Begin section III-6.10.2 to use HPDATA dry scrubber costs.
- Begin section III-6.10.3 to use USER-specified SO_2 control costs.

6.10.1 No SO_2 control

Variables

<u>Defined in section III-6.4</u>
qt = qualified technology types.

<u>Calculated in this section</u>
SAPC[**qt**] = SO_2 air pollution control costs for technology type **qt** ($).

Calculations

For each qualified technology, **qt**, do the following.

SAPC[**qt**] = $0

(Begin section III-6.11)

6.10.2 Dry scrubber

When a dry scrubber is chosen as the SO_2 control, a baghouse is automatically chosen for the particulate control. The capital costs for the baghouse are included in this calculation of the capital costs for SO_2 control unless the sulfur content of the fuel is less than 0.5 percent, in which case the baghouse costs are calculated in section III-6.11.2.

Variables

Defined in section III-6.4
qt = qualified technology types.

From HPDATA file (*.CDA), FUELS data table
SULFUR[**qt**] = sulfur found in fuel as a percentage of fuel weight for technology type **qt** (%).

From HPDATA file (*.CDA), CAPITAL COSTS data table
A[**qt**] = SO_2 control dry scrubber capital cost coefficient for technology type **qt** ($/MBtu/hr).

Program constants
B[**qt**] = 0.60 = SO_2 control dry scrubber capital cost exponent for technology type **qt** (scalar). **B**[**qt**] is the slope of a line fit to a log-log graph plotting dry scrubber capital cost ($) versus boiler size (MBtu/hr).

Defined in section III-6.3
TOTPLANTCAP = total plant capacity (MBtu/hr).

Defined in section III-6.6
CCESCAL = capital cost escalation factor (scalar).

Calculated in this section
SAPC[**qt**] = SO_2 air pollution control costs for technology type **qt** ($).
PAPC[**qt**] = particulate air pollution control costs for technology type **qt** ($).

Calculations

For each qualified technology, **qt**, do the following.

If **SULFUR**[**qt**] < 0.5%

Then **SAPC**[**qt**] = $0 (there is no SO_2 control)

(Begin section III-6.11.2)

Else **SAPC**[**qt**] = (**A**[**qt**]***TOTPLANTCAP**$^{\mathbf{B}[\mathbf{qt}]}$)***CCESCAL**
PAPC[**qt**] = $0

(Begin section III-6.12)

End If

6.10.3 User-specified SO_2 control costs

Variables

<u>Defined in section III-6.4</u>
qt = qualified technology types.

<u>From HPDATA file (*.CDA), FUELS data table</u>
SULFUR[qt] = sulfur found in fuel as a percentage of fuel weight for technology type **qt** (%).

<u>From HPDATA file (*.CDA), CAPITAL COST INDICES data table</u>
CCINDEX[SCOSTYR] = capital cost index for the year **SCOSTYR** (scalar).
CCINDEX[STUDYR] = capital cost index for the year **STUDYR** (scalar).

<u>USER-specified</u>
USERSAPC = user entered SO_2 air pollution control capital cost ($).
SCOSTYR = year for which SO_2 control cost data is valid (year).

<u>Defined in section III-6.6</u>
STUDYR = year of study (year).

<u>Calculated in this section</u>
SCCESCAL = SO_2 control capital cost escalation factor (scalar).
SAPC[qt] = SO_2 air pollution control costs for technology type **qt** ($).

Calculations

For each qualified technology, **qt**, do the following.

If **SULFUR[qt]** < 0.5%

Then (there is no SO_2 control)

SAPC[qt] = $0

(Begin section III-6.11)

Else

SCCESCAL = **CCINDEX[STUDYR]**/**CCINDEX[SCOSTYR]**

SAPC[qt] = **USERSAPC*SCCESCAL**

(Begin section III-6.11)

End If

6.11 Particulate Air Pollution Control Capital Cost

- Begin section III-6.11.1 if there is no particulate control.
- Begin section III-6.11.2 to use HPDATA baghouse costs.
- Begin section III-6.11.3 to use HPDATA electro-static precipitator costs.
- Begin section III-6.11.4 to use USER-specified particulate control costs.

6.11.1 No particulate control

Variables

Defined in section III-6.4
qt = qualified technology types.

Calculated in this section
PAPC[qt] = particulate air pollution control costs for technology type **qt** ($).

Calculations

For each qualified technology, **qt**, do the following.

PAPC[qt] = $0

(Begin section III-6.12)

6.11.2 Baghouse

For the case where a dry scrubber has been chosen as the SO_2 control technology and the sulfur content of the fuel being used is less than 0.5 percent, then there is no SO_2 control and baghouse capital costs must be calculated.

Variables

Defined in section III-6.4
qt = qualified technology types.

From HPDATA file (*.CDA), FUELS data table
ASH[qt] = ash weight as a percentage of fuel weight for technology type **qt** (%).

From HPDATA file (*.CDA), CAPITAL COSTS data table
A[qt] = baghouse capital cost coefficient for technology type **qt** ($/MBtu/hr).

Program constants
B[qt] = 0.77 = baghouse capital cost exponent for technology type **qt** (scalar). **B[qt]** is the slope of a line fit to a log-log graph plotting baghouse capital cost ($) versus boiler size (MBtu/hr).

Defined in section III-6.3
TOTPLANTCAP = total plant capacity (MBtu/hr).

Defined in section III-6.6
CCESCAL = capital cost escalation factor (scalar).

Calculated in this section
PAPC[qt] = particulate air pollution control costs for technology type **qt** ($).

Calculations

For each qualified technology, **qt**, do the following.

If **ASH[qt]** < 1.00%

Then (there is no particulate control)

PAPC[qt] = $0

(Begin section III-6.12)

Else

PAPC[qt] = (**A[qt]** * $\mathbf{TOTPLANTCAP}^{\mathbf{B[qt]}}$) * **CCESCAL**

(Begin section III-6.12)

End If

6.11.3 Electro-static precipitator (ESP)

Variables

Defined in section III-6.4
qt = qualified technology types.

From HPDATA file (*.CDA), FUELS data table
ASH[qt] = ash weight as a percentage of fuel weight for technology type **qt** (%).

From HPDATA file (*.CDA), CAPITAL COSTS data table
A[qt] = ESP capital cost coefficient for technology type **qt** ($/MBtu/hr).

Program constants
B[qt] = 0.60 = ESP capital cost exponent for technology type **qt** (scalar). **B[qt]** is the slope of a line fit to a log-log graph plotting ESP capital cost ($) versus boiler size (MBtu/hr).

Defined in section III-6.3
TOTPLANTCAP = total plant capacity (MBtu/hr).

Defined in section III-6.6
CCESCAL = capital cost escalation factor (scalar).

Calculated in this section
PAPC[qt] = particulate air pollution control costs for technology type **qt** ($).

Calculations

For each qualified technology, **qt**, do the following.

If **ASH[qt]** < 1.00%

Then (there is no particulate control)

PAPC[qt] = $0

(Begin section III-6.12)

Else

$$PAPC[qt] = (A[qt] * TOTPLANTCAP^{B[qt]}) * CCESCAL$$

(Begin section III-6.12)

End If

6.11.4 User-specified particulate control costs

Variables

Defined in section III-6.4
qt = qualified technology types.

From HPDATA file (*.CDA), FUELS data table
ASH[qt] = ash weight as a percentage of fuel weight for technology type **qt** (%).

From HPDATA file (*.CDA), CAPITAL COST INDICES data table
CCINDEX[PCOSTYR] = capital cost index for the year **PCOSTYR** (scalar).
CCINDEX[STUDYR] = capital cost index for the year **STUDYR** (scalar).

USER-specified
USERPAPC = user entered particulate air pollution control costs ($).
PCOSTYR = year for which particulate control cost data is valid (year).

Defined in section III-6.6
STUDYR = year of study (year).

Calculated in this section
PCCESCAL = particulate control capital cost escalation factor (scalar).
PAPC[qt] = particulate air pollution control costs for technology type **qt** ($).

Calculations

For each qualified technology, **qt**, do the following.

If **ASH[qt]** < 1.00%

Then (there is no particulate control)

PAPC[qt] = $0

(Begin section III-6.12)

Else

PCCESCAL = **CCINDEX[STUDYR]/CCINDEX[PCOSTYR]**

PAPC[qt] = **USERPAPC*PCCESCAL**

(Begin section III-6.12)

End If

6.12 TOTAL Air Pollution Control Capital Cost

Variables

Defined in section III-6.4
qt = qualified technology types.

Defined in section III-6.10
SAPC[**qt**] = SO_2 air pollution control costs for technology type **qt** ($).

Defined in section III-6.11
PAPC[**qt**] = particulate air pollution control costs for technology type **qt** ($).

Calculated in this section
TOTAPC[**qt**] = total air pollution control cost for technology type **qt** ($).

Calculations

For each qualified technology, **qt**, do the following.

TOTAPC[**qt**] = **SAPC**[**qt**] + **PAPC**[**qt**]

(Begin section III-6.13)

6.13 TOTAL Asset Cost

Variables

Defined in section III-6.4
qt = qualified technology types.

Defined in section III-6.7
PEC[**qt**] = purchased equipment cost for technology type **qt** ($).

Defined in section III-6.8
BOP[**qt**] = balance of plant cost for technology type **qt** ($).

Defined in section III-6.9
RET[**qt**] = retrofit adjustment for technology type **qt** ($).

Defined in section III-6.12
TOTAPC[**qt**] = total air pollution control cost for technology type **qt** ($).

Calculated in this section
TOTASSETS[qt] = total capital cost for all hard assets for technology type **qt** ($).

Calculations

For each qualified technology, **qt**, do the following.

TOTASSETS[**qt**] = **PEC**[**qt**] + **BOP**[**qt**] + **RET**[**qt**] + **TOTAPC**[**qt**]

(Begin section III-6.14)

6.14 Engineering, Design, and Construction Management Cost

Variables

Defined in section III-6.4
qt = qualified technology types.

From HPDATA file (*.CDA), MISCELLANEOUS PARAMETERS data table
PCTEDC = engineering, design, and construction management cost as a percentage of total asset cost (%).

Defined in section III-6.13
TOTASSETS[**qt**] = total capital cost for all hard assets for technology type **qt** ($).

Calculated in this section
EDC[**qt**] = engineering, design, and construction management cost for technology type **qt** ($).

Calculations

For each qualified technology, **qt**, do the following.

EDC[**qt**] = **TOTASSETS**[**qt**]*__PCTEDC__/100%

(Begin section III-6.15)

6.15 Contingency Cost

Variables

Defined in section III-6.4
qt = qualified technology types.

From HPDATA file (*.CDA), MISCELLANEOUS PARAMETERS data table
PCTCONTIN = percentage of the capital cost that reflects unforeseen events during construction that may add to the total capital cost (%).

Defined in section III-6.13
TOTASSETS[**qt**] = total capital cost for all hard assets for technology type **qt** ($).

Defined in section III-6.14
EDC[**qt**] = engineering, design, and construction management cost for technology type **qt** ($).

Calculated in this section
CONTIN[**qt**] = contingency cost for technology type **qt** ($).

Calculations

For each qualified technology, **qt**, do the following.

CONTIN[**qt**] = (**TOTASSETS**[**qt**] + **EDC**[**qt**])***PCTCONTIN**/100%

(Begin section III-6.16)

6.16 TOTAL CAPITAL COST

Variables

Defined in section III-6.4
qt = qualified technology types.

Defined in section III-6.13
TOTASSETS[**qt**] = total capital cost for all hard assets for technology type **qt** ($).

Defined in section III-6.14
EDC[**qt**] = engineering, design, and construction management cost for technology type **qt** ($).

Defined in section III-6.15
CONTIN[**qt**] = contingency cost for technology type **qt** ($).

Calculated in this section
TOTCAPCOST[**qt**] = total capital cost for technology type **qt** ($).

Calculations

For each qualified technology, **qt**, do the following.

TOTCAPCOST[**qt**] = **TOTASSETS**[**qt**] + **EDC**[**qt**] + **CONTIN**[**qt**]

(Begin section III-6.17)

6.17 Operating Cost Escalation Factors

Variables

Program variables
com = commodity type

Water Treatment	Fuel: Coal
Operational Labor	Fuel: Wood
Supervisory Labor	Fuel: Option 1
Fuel: #2 Oil	Electricity
Fuel: #6 Oil	Waste Disposal
Fuel: Natural Gas	Lime

From HPDATA file (*.CDA), O&M COSTS data table
RRESCAL[**com**] = real rate of price escalation for commodity **com** (%).

From HPDATA file (*.CDA), MISCELLANEOUS PARAMETERS data table
COSTYR = year for which annual cost data applies (year).
INFLATION = annual inflation rate (%).

Defined in section III-6.6
STUDYR = year of study (year).

Calculated in this section
OCESCAL[WaterTreat] = cost escalation factor for water treatment (scalar).
OCESCAL[OpLabor] = cost escalation factor for operational labor (scalar).
OCESCAL[SupLabor] = cost escalation factor for supervisory labor (scalar).
OCESCAL[#2_Oil] = cost escalation factor for No. 2 Oil (scalar).
OCESCAL[#6_Oil] = cost escalation factor for No. 6 Oil (scalar).
OCESCAL[NatGas] = cost escalation factor for natural gas (scalar).
OCESCAL[Coal] = cost escalation factor for coal (scalar).
OCESCAL[Wood] = cost escalation factor for wood (scalar).
OCESCAL[Option 1] = cost escalation factor for Option 1 fuel (scalar).
OCESCAL[Elect] = cost escalation factor for purchased electricity (scalar).
OCESCAL[WasteDisp] = cost escalation factor for waste disposal (scalar).
OCESCAL[Lime] = cost escalation factor for quicklime (scalar).

Calculations

For each commodity, **com**, do the following.

$$\mathbf{OCESCAL}[\mathbf{com}] = (1.0 + \mathbf{RRESCAL}[\mathbf{com}]/100\% + \mathbf{INFLATION}/100\%)^{\mathbf{STUDYR}\ -\ \mathbf{COSTYR}}$$

(Begin section III-6.18)

6.18 Operational and Supervisory Labor Cost (not including APC)

Variables

Defined in section III-6.4
qt = qualified technology types.

From HPDATA file (*.CDA), TECHNOLOGY TYPES data table
OPLABOR[**qt**]= operational labor required for technology type **qt** (men/shift).
SUPLABOR[**qt**]= supervisory labor required for technology type **qt** (men/day).
UNITMULT[**qt**]= unit multiplier for operational labor for technology type **qt** (scalar).

From HPDATA file (*.CDA), O&M COSTS data table
OPLABCOST = unit operational labor cost ($/manhr).
SUPLABCOST = unit supervisory labor cost ($/manhr).

Defined in section III-6.3
NUMBOIL = number of boilers (1-3), not including backup boiler.

Defined in section III-6.17
OCESCAL[OpLabor] = cost escalation factor for operational labor (scalar).
OCESCAL[SupLabor] = cost escalation factor for supervisory labor (scalar).

Calculated in this section
LABOR[**qt**] = annual labor cost for technology type **qt** ($).

Calculations

For each qualified technology, **qt**, do the following.

LABOR[**qt**] = (8 hrs/man)***OPLABOR**[**qt**]*(3 shifts/day)*(7 days/week)*
(52 weeks/yr)***OPLABCOST***(1 + (**NUMBOIL** - 1)***UNITMULT**[**qt**])*
OCESCAL[OpLabor]
+
(8 hrs/man)***SUPLABOR**[**qt**]*(5 days/week)*(52 weeks/yr)*
SUPLABCOST***OCESCAL**[SupLabor]

(Begin section III-6.19)

6.19 Non-Labor O&M Cost (not including APC)

Variables

Defined in section III-6.4
qt = qualified technology types.

From HPDATA file (*.CDA), TECHNOLOGY TYPES data table
PCTMAINT[qt]= maintenance cost as a percentage of total capital cost (not including air pollution control costs) for technology type **qt** (%).

From HPDATA file (*.CDA), MISCELLANEOUS PARAMETERS data table
PCTEDC = engineering, design, and construction management cost as a percentage of total asset cost (%).
PCTCONTIN = percentage of the capital cost that reflects unforeseen events during construction that may add to the total capital cost (%).

Defined in section III-6.7
PEC[qt] = purchased equipment cost for technology type **qt** ($).

Defined in section III-6.8
BOP[qt] = balance of plant cost for technology type **qt** ($).

Calculated in this section
MAINT[qt] = annual maintenance cost for technology type **qt** ($).

Calculations

For each qualified technology, **qt**, do the following.

MAINT[qt] = (**PEC[qt]** + **BOP[qt]**)*(1 + **PCTEDC**/100%)*(1 + **PCTCONTIN**/100%)*
PCTMAINT[qt]/100%

(Begin section III-6.20)

6.20 Operational Fuel Cost

Variables

Defined in section III-6.4
qt = qualified technology types.

Program variables
com = commodity type

Fuel: #2 Oil	Fuel: Coal
Fuel: #6 Oil	Fuel: Wood
Fuel: Natural Gas	Fuel: Option 1

From HPDATA file (*.CDA), FUELS data table
HHV[**qt**] = higher heating value for the fuel corresponding to technology type **qt**
(Btu/lb -- No. 2 Oil),
(Btu/lb -- No. 6 Oil),
(Btu/cf -- Natural Gas),
(Btu/lb -- Coal),
(Btu/lb -- Wood), and
(Btu/lb -- Option 1).

CONV[**qt**] = conversion factor for the fuel corresponding to technology type **qt**
(lb/gal -- No. 2 Oil),
(lb/gal -- No. 6 Oil),
(cf/kscf -- Natural Gas),
(lb/ton -- Coal),
(lb/ton -- Wood), and
(lb/gal -- Option 1).

From HPDATA file (*.CDA), TECHNOLOGY TYPES data table
EFF[**qt**] = boiler efficiency for technology type **qt** (%).

From HPDATA file (*.CDA), O&M COSTS data table
FUELCOST[**com**] = unit fuel cost for the fuel type, **com**, corresponding to technology type **qt**
($/gal -- No. 2 Oil),
($/gal -- No. 6 Oil),
($/kscf -- Natural Gas),
($/ton -- Coal),
($/ton -- Wood), and
($/gal -- Option 1).

Defined in section III-6.1
ANNLOAD = total annual load (MBtu/yr).

Defined in section III-6.17
OCESCAL[**com**] = cost escalation factor for fuel type, **com**, corresponding to technology type **qt** (scalar).

Calculated in this section
FUEL[**qt**] = annual fuel cost for technology type **qt** ($).

Calculations

For each qualified technology, **qt**, do the following.

$$\mathbf{FUEL[qt]} = \frac{\mathbf{ANNLOAD}*(1{,}000{,}000\ \mathrm{Btu/MBtu})}{\mathbf{HHV[qt]}*\mathbf{CONV[qt]}*(\mathbf{EFF[qt]}/100\%)}*\mathbf{FUELCOST[com]}*\mathbf{OCESCAL[com]}$$

(Begin section III-6.21)

6.21 Operational Power Cost

Variables

Defined in section III-6.4
qt = qualified technology types.

From HPDATA file (*.CDA), TECHNOLOGY TYPES data table
PSPOWER[qt] = parasitic power as a percentage of the total annual load for technology type **qt** (%).

From HPDATA file (*.CDA), O&M COSTS data table
ELECTCOST = unit electrical cost ($/kWh).

Defined in section III-6.1
ANNLOAD = total annual load (MBtu/yr).

Defined in section III-6.17
OCESCAL[Elect] = cost escalation factor for purchased electricity (scalar).

Calculated in this section
POWER[qt] = annual power cost for technology type **qt** ($).

Calculations

For each qualified technology, **qt**, do the following.

$$\mathbf{POWER[qt]} = \mathbf{ANNLOAD}*(1{,}000{,}000\ \mathrm{Btu/MBtu})/(3{,}412\ \mathrm{Btu/kWh})*(\mathbf{PSPOWER[qt]}/100\%)*(\mathbf{ELECTCOST}*\mathbf{OCESCAL}[\mathrm{Elect}])$$

(Begin section III-6.22)

6.22 Air Pollution Control Operating Cost Escalation Factor

Variables

<u>From HPDATA file (*.CDA), MISCELLANEOUS PARAMETERS data table</u>
COSTYR = year for which annual cost data applies (year).
INFLATION = annual inflation rate (%).

<u>Defined in section III-6.6</u>
STUDYR = year of study (year).

<u>Calculated in this section</u>
APCESCAL = air pollution control operating cost escalation factor (scalar).

Calculations

$$\mathbf{APCESCAL} = (1.0 + \mathbf{INFLATION}/100\%)^{\mathbf{STUDYR}\ -\ \mathbf{COSTYR}}$$

(Begin section III-6.23)

6.23 Operational SO_2 Air Pollution Control Cost

- Begin section III-6.23.1 if there is no SO_2 control.
- Begin section III-6.23.2 to use HPDATA dry scrubber costs.
- Begin section III-6.23.3 to use USER-specified SO_2 control costs.

6.23.1 No SO_2 control

Variables

<u>Defined in section III-6.4</u>
qt = qualified technology types.

<u>Calculated in this section</u>
OCSAPC[qt] = SO_2 control operating cost for technology type **qt** ($/yr).

Calculations

For each qualified technology, **qt**, do the following.

OCSAPC[qt] = $0/yr

(Begin section III-6.24)

6.23.2 Dry scrubber

When a dry scrubber is chosen as the SO_2 control (and assigned a capital cost in section III-6.10.2), a baghouse is automatically chosen for the particulate control. Unless the sulfur content of the fuel is less than 0.5 percent, in which case the baghouse operating costs are calculated in section III-6.24.2, the operating costs for the baghouse (as well as all water costs associated with SO_2 removal) are included in this calculation of the operating costs for SO_2 control.

The operating cost calculations for SO_2 control include the cost of lime. To more accurately reflect this cost, the quantity of lime consumed through dry scrubber operation is computed. The following is a chemical description of the SO_2 collection process.

Let, CaO = quicklime (Delivered quicklime is 90 percent pure.)
H_2O = water
$Ca(OH)_2$ = calcium hydroxide
STR = stoichiometric ratio
SO_2 = sulfur dioxide
O_2 = oxygen
$CaSO_3$ = calcium sulfite
$CaSO_4$ = calcium sulfate

1) Purchased quicklime is converted into a lime slurry.

$$CaO + H_2O \Rightarrow Ca(OH)_2$$

2) The lime slurry enters the spray dryer to remove sulfur dioxide.

$$STR*Ca(OH)_2 + SO_2 + H_2O + 1/4O_2 \Rightarrow$$
$$(STR - 1)*Ca(OH)_2 + 2H_2O + 1/2(CaSO_3 + CaSO_4)$$

The products of this reaction form sludge. Sludge is a waste product which must discarded. (The disposal cost for sludge is calculated in section III-6.26.)

3) The stoichiometric ratio determines the SO_2 collection efficiency. Note: STR must be greater than or equal to one.

For STR = 1.5 : 70% of the SO_2 is collected*
For STR = 2.0 : 90% of the SO_2 is collected*
For STR = 2.5 : 94% of the SO_2 is collected*

* Note: These efficiencies come from the Institute of Gas Technology's, *Coal-Fired Boiler Evaluation Program*, Vol 1 (July 1990).

Variables

Program constants
SO2 = 64.06 = atomic mass of sulfur dioxide, SO_2.
S = 32.06 = atomic mass of sulfur, S.
CAO = 56.08 = atomic mass of quicklime, CaO.
PURITY = 0.90 = delivered quicklime is assumed to be 90% pure (scalar).

Defined in section III-6.4
qt = qualified technology types.

From HPDATA file (*.CDA), FUELS data table
HHV[**qt**] = higher heating value for the fuel corresponding to technology type **qt** (Btu/lb -- No. 2 Oil), (Btu/lb -- No. 6 Oil), (Btu/cf -- Natural Gas), (Btu/lb -- Coal), (Btu/lb -- Wood), and (Btu/lb -- Option 1).
CONV[**qt**] = conversion factor for the fuel corresponding to technology type **qt** (lb/gal -- No. 2 Oil), (lb/gal -- No. 6 Oil), (cf/kscf -- Natural Gas), (lb/ton -- Coal), (lb/ton -- Wood), and (lb/gal -- Option 1).
SULFUR[**qt**] = sulfur found in fuel as a percentage of fuel weight for technology type **qt** (%).

From HPDATA file (*.CDA), TECHNOLOGY TYPES data table
EFF[**qt**] = boiler efficiency for technology type **qt** (%).

From HPDATA file (*.CDA), O&M COSTS data table
LIMECOST = the unit cost for quicklime ($/ton).
A = dry scrubber operating cost coefficient ($/MBtu/hr).
B = dry scrubber operating cost exponent (scalar).
C = cost coefficient which adjusts the dry scrubber operating cost based on the annual plant load ($/MBtu/yr).

From HPDATA file (*.CDA), MISCELLANEOUS PARAMETERS data table
STR = stoichiometric ratio which indicates the number of units of lime used to remove one unit of SO_2 (scalar).

Defined in section III-6.1
ANNLOAD = total annual load (MBtu/yr).

Defined in section III-6.3
TOTPLANTCAP = total plant capacity (MBtu/hr).

Defined in section III-6.17
OCESCAL[Lime] = cost escalation factor for quicklime (scalar).

Defined in section III-6.22

APCESCAL = air pollution control operating cost escalation factor (scalar).

Calculated in this section

FUELCONS[**qt**] = fuel consumption for technology type **qt**
(gal/yr -- No. 2 Oil),
(gal/yr -- No. 6 Oil),
(kscf/yr -- Natural Gas),
(ton/yr -- Coal),
(ton/yr -- Wood), and
(gal/yr -- Option 1).

SO2OUT[**qt**] = quantity of SO_2 exiting boiler for technology type **qt** (tons/yr).

LIME[**qt**] = annual lime consumption for technology type **qt** (tons/yr).

OCSAPC[**qt**] = SO_2 control operating cost for technology type **qt** ($/yr).

OCPAPC[**qt**] = particulate control operating cost for technology type **qt** ($/yr).

Calculations

For each qualified technology, **qt**, do the following.

$$\mathbf{FUELCONS}[\mathbf{qt}] = \frac{\mathbf{ANNLOAD} * (1{,}000{,}000 \text{ Btu/MBtu})}{\mathbf{HHV}[\mathbf{qt}] * \mathbf{CONV}[\mathbf{qt}] * (\mathbf{EFF}[\mathbf{qt}]/100\%)}$$

$$\mathbf{SO2OUT}[\mathbf{qt}] = \frac{\mathbf{FUELCONS}[\mathbf{qt}] * \mathbf{CONV}[\mathbf{qt}] * \mathbf{SULFUR}[\mathbf{qt}] * \mathbf{SO2}}{(2{,}000 \text{ lbs/ton}) * 100\% * \mathbf{S}}$$

$$\mathbf{LIME}[\mathbf{qt}] = \mathbf{STR} * \frac{\mathbf{SO2OUT}[\mathbf{qt}] * (\mathbf{CAO/SO2})}{\mathbf{PURITY}}$$

$$\mathbf{OCSAPC}[\mathbf{qt}] = (\mathbf{A} * \mathbf{TOTPLANTCAP}^{\mathbf{B}} + \mathbf{C} * \mathbf{ANNLOAD}) * \mathbf{APCESCAL} + \mathbf{LIME}[\mathbf{qt}] * \mathbf{LIMECOST} * \mathbf{OCESCAL}[\text{Lime}]$$

$$\mathbf{OCPAPC}[\mathbf{qt}] = \$0/\text{yr}$$

(Begin section III-6.25)

6.23.3 User-specified SO_2 Control cost

Variables

<u>Defined in section III-6.4</u>
qt = qualified technology types.

<u>From HPDATA file (*.CDA), CAPITAL COST INDICES data table</u>
CCINDEX[**SCOSTYR**] = O&M cost index for the year **SCOSTYR** (scalar).
CCINDEX[**STUDYR**] = O&M cost index for the year **STUDYR** (scalar).

<u>USER-specified</u>
SCOSTYR = year for which SO_2 control cost data is valid (year).
USERSAPCOM = user entered SO_2 control annual operations & maintenance cost ($/yr).

NOTE: **USERSAPCOM** must include all consumables such as lime, labor, and spare parts

<u>Defined in section III-6.6</u>
STUDYR = year of study (year).

<u>Calculated in this section</u>
SOCESCAL = SO_2 control operating cost escalation factor (scalar).
OCSAPC[**qt**] = SO_2 control operating cost for technology type **qt** ($/yr).

Calculations

For each qualified technology, **qt**, do the following.

SOCESCAL = **CCINDEX**[**STUDYR**]/**CCINDEX**[**SCOSTYR**]

OCSAPC[**qt**] = **USERSAPCOM*SOCESCAL**

(Begin section III-6.24)

6.24 Operational Particulate Air Pollution Control Cost

- Begin section III-6.24.1 if there is no particulate control.
- Begin section III-6.24.2 to use HPDATA baghouse costs.
- Begin section III-6.24.3 to use HPDATA electro-static precipitator costs.
- Begin section III-6.24.4 to use USER-specified particulate control costs.

6.24.1 No particulate control

Variables

Defined in section III-6.4
qt = qualified technology types.

Calculated in this section
OCPAPC[**qt**] = particulate control operating cost for technology type **qt** ($/yr).

Calculations

For each qualified technology, **qt**, do the following.

OCPAPC[**qt**] = $0/yr

(Begin section III-6.25)

6.24.2 Baghouse

For the case where a dry scrubber has been chosen as the SO_2 control technology and the sulfur content of the fuel being used is less than 0.5 percent, then there is no SO_2 control and baghouse operating costs must be calculated.

Variables

Defined in section III-6.4
qt = qualified technology types.

From HPDATA file (*.CDA), O&M COSTS data table
A = baghouse operating cost coefficient ($/MBtu/hr).
B = baghouse operating cost exponent (scalar).
C = cost coefficient which adjusts the baghouse operating cost based on the annual plant load ($/MBtu/yr).

Defined in section III-6.1
ANNLOAD = total annual load (MBtu/yr).

Defined in section III-6.3
TOTPLANTCAP = total plant capacity (MBtu/hr).

Defined in section III-6.3
TOTPLANTCAP = total plant capacity (MBtu/hr).

Defined in section III-6.22
APCESCAL = air pollution control operating cost escalation factor (scalar).

Calculated in this section
OCPAPC[**qt**] = particulate control operating cost for technology type **qt** ($/yr).

Calculations

For each qualified technology, **qt**, do the following.

$$\mathbf{OCPAPC[qt] = (A*TOTPLANTCAP^{B} + C*ANNLOAD)*APCESCAL}$$

(Begin section III-6.25)

6.24.3 Electro-static precipitator (ESP)

Variables

Defined in section III-6.4
qt = qualified technology types.

From HPDATA file (*.CDA), O&M COSTS data table
A = ESP operating cost coefficient ($/MBtu/hr).
B = ESP operating cost exponent (scalar).
C = cost coefficient which adjusts the ESP operating cost based on the annual plant load ($/MBtu/yr).

Defined in section III-6.1
ANNLOAD = total annual load (MBtu/yr).

Defined in section III-6.3
TOTPLANTCAP = total plant capacity (MBtu/hr).

Defined in section III-6.22
APCESCAL = air pollution control operating cost escalation factor (scalar).

Calculated in this section
OCPAPC[**qt**] = particulate control operating cost for technology type **qt** ($/yr).

Calculations

For each qualified technology, **qt**, do the following.

$$\mathbf{OCPAPC}[\mathbf{qt}] = (\mathbf{A} * \mathbf{TOTPLANTCAP}^{\mathbf{B}} + \mathbf{C} * \mathbf{ANNLOAD}) * \mathbf{APCESCAL}$$

(Begin section III-6.25)

6.24.4 User-specified particulate control cost

Variables

Defined in section III-6.4
qt = qualified technology types.

From HPDATA file (*.CDA), CAPITAL COST INDICES data table
CCINDEX[**PCOSTYR**] = O&M cost index for the year **PCOSTYR** (scalar).
CCINDEX[**STUDYR**] = O&M cost index for the year **STUDYR** (scalar).

USER-specified
PCOSTYR = year for which particulate control cost data is valid (year).
USERPAPCOM = user-entered particulate control annual operations & maintenance cost ($/yr).

Defined in section III-6.6
STUDYR = year of study (year).

Calculated in this section
POCESCAL = particulate control operating cost escalation factor (scalar).
OCPAPC[**qt**] = particulate control operating cost for technology type **qt** ($/yr).

Calculations

For each qualified technology, **qt**, do the following.

POCESCAL = **CCINDEX**[**STUDYR**]/**CCINDEX**[**PCOSTYR**]

OCPAPC[**qt**] = **USERPAPCOM*****POCESCAL**

(Begin section III-6.25)

6.25 TOTAL Operational Air Pollution Control Cost

Variables

Defined in section III-6.4
qt = qualified technology types.

Defined in section III-6.23
OCSAPC[**qt**] = SO_2 control operating cost for technology type **qt** ($/yr).

Defined in section III-6.24
OCPAPC[**qt**] = particulate control operating cost for technology type **qt** ($/yr).

Calculated in this section
TOTOCAPC[**qt**] = total air pollution control operating cost for technology type **qt** ($/yr).

Calculations

For each qualified technology, **qt**, do the following.

TOTOCAPC[**qt**] = **OCSAPC**[**qt**] + **OCPAPC**[**qt**]

(Begin section III-6.26)

6.26 Waste Disposal Cost

Variables

Program constants
CAO = 56.08 = atomic mass of quicklime, CaO.
SO2 = 64.06 = atomic mass of sulfur dioxide, SO_2.
CASO3 = 120.14 = atomic mass of calcium sulfite, $CaSO_3$.
CASO4 = 136.14 = atomic mass of calcium sulfate, $CaSO_4$.
H2O = 18.01 = atomic mass of water, H_2O.
CAOH2 = 74.09 = atomic mass of calcium hydroxide, $Ca(OH)_2$.
CAPTURE = 0.80 = ash capture is assumed to be 80 percent when there is no particulate control (scalar).

Defined in section III-6.4
qt = qualified technology types.

From HPDATA file (*.CDA), FUELS data table
ASH[qt] = ash weight as a percentage of fuel weight for technology type **qt** (%).
HHV[qt] = higher heating value for the fuel corresponding to technology type **qt** (Btu/lb -- No. 2 Oil),
(Btu/lb -- No. 6 Oil),
(Btu/cf -- Natural Gas),
(Btu/lb -- Coal),
(Btu/lb -- Wood), and
(Btu/lb -- Option 1).

From HPDATA file (*.CDA), TECHNOLOGY TYPES data table
EFF[qt] = boiler efficiency for technology type **qt** (%).

From HPDATA file (*.CDA), O&M COSTS data table
WASTEDISP = the unit cost of waste disposal ($/ton).

From HPDATA file (*.CDA), MISCELLANEOUS PARAMETERS data table
STR = stoichiometric ratio which indicates the number of units of lime used to remove one unit of SO_2 (scalar).

Defined in section III-6.1
ANNLOAD = total annual load (MBtu/yr).

Defined in section III-6.17
OCESCAL[WasteDisp] = cost escalation factor for waste disposal (scalar).

Defined in section III-6.23.2
LIME[qt] = annual lime consumption for technology type **qt** (tons/yr).

Calculated in this section
SLRATIO = mass ratio of the reaction products versus the input quicklime for dry scrubber SO_2 control (scalar). (See section III-6.23.2 for a description of the chemical reaction.)

SLUDGE[**qt**] = quantity of waste produced from dry scrubber operation for technology type **qt** (tons/yr).

ASHWASTE[**qt**] = quantity of ash produced for technology type **qt** (tons/yr).

WASTE[**qt**] = the annual cost of waste disposal for technology type **qt** ($/yr).

Calculations

If SO_2 emissions are controlled by a dry scrubber

Then

$$\mathbf{SLRATIO} = \frac{\mathbf{(STR - 1)*CAOH2 + 2*H20 + 0.5*(CASO3 + CASO4)}}{\mathbf{STR*CAO}}$$

For each qualified technology, **qt**, do the following.

SLUDGE[**qt**] = **LIME**[**qt**]***SLRATIO**

Else (SO_2 emissions <u>not</u> controlled by a dry scrubber)

SLUDGE[**qt**] = 0 tons/yr

End If

If **ASH**[**qt**] < 1.00%

Then **WASTE**[**qt**] = (**SLUDGE**[**qt**]***WASTEDISP**)***OCESCAL**[WasteDisp]

(Begin section III-6.27)

Else

$$\mathbf{ASHWASTE}[\mathbf{qt}] = \frac{\mathbf{ANNLOAD}*(1{,}000{,}000\ \text{Btu/MBtu})*(\mathbf{ASH}[\mathbf{qt}]/100\%)}{(2{,}000\ \text{lb/ton})*\mathbf{HHV}[\mathbf{qt}]*(\mathbf{EFF}[\mathbf{qt}]/100\%)}$$

If there is no particulate control

Then

ASHWASTE[**qt**] = **ASHWASTE**[**qt**]***CAPTURE**

End If

WASTE[**qt**] = (**SLUDGE**[**qt**] + **ASHWASTE**[**qt**])***WASTEDISP*** **OCESCAL**[WasteDisp]

(Begin section III-6.27)

End If

6.27 Tax and Insurance Expense

Variables

Defined in section III-6.4
qt = qualified technology types.

From HPDATA file (*.CDA), MISCELLANEOUS PARAMETERS data table
TAXINSPCT = annual taxes and insurance cost as a percentage of total capital cost (%).

Defined in section III-6.16
TOTCAPCOST[**qt**] = total capital cost for technology type **qt** ($).

Calculated in this section
TAXINS[**qt**] = annual taxes and insurance for technology type **qt** ($/yr).

Calculations

For each qualified technology, **qt**, do the following.

TAXINS[**qt**] = **TOTCAPCOST**[**qt**]*(**TAXINSPCT**/100%)

(Begin section III-6.28)

6.28 Boiler Water Expense

- Begin section III-6.28.1 for a hot water boiler system.
- Begin section III-6.28.2 for a steam boiler system.

6.28.1 Hot water boiler system

Variables

Defined in section III-6.4
qt = qualified technology types.

Calculated in this section
WATER[**qt**] = annual water cost for technology type **qt** ($/yr).

Calculations

For each qualified technology, **qt**, do the following.

WATER[**qt**] = $0/yr

(Begin section III-6.29)

6.28.2 Steam boiler system

Variables

Program constants
BLWDWN = 0.05 = water lost due to blowdown is assumed to be 5% (scalar).

Defined in section III-6.4
qt = qualified technology types.

From HPDATA file (*.CDA), O&M COSTS data table
WATERTREAT = the unit cost of water treatment ($/1,000 gal).

Defined in section III-6.2.2
COND = fraction of steam returned as condensate (scalar).
ANNUALSTEAM = total annual steam flow (lbm/yr).

Defined in section III-6.17
OCESCAL[WaterTreat] = cost escalation factor for water treatment (scalar).

Calculated in this section
WATERUSE[**qt**] = annual water consumption for technology type **qt** (1,000 gal/yr).
WATER[**qt**] = annual water cost for technology type **qt** ($/yr).

Calculations

For each qualified technology, **qt**, do the following.

$$\mathbf{WATERUSE}[\mathbf{qt}] = \frac{(1 + \mathbf{BLWDWN} - \mathbf{COND}) * \mathbf{ANNUALSTEAM}}{(8{,}340 \text{ lbm/thous. gal})}$$

$$\mathbf{WATER}[\mathbf{qt}] = (\mathbf{WATERUSE}[\mathbf{qt}] * \mathbf{WATERTREAT}) * \mathbf{OCESCAL}[\text{WaterTreat}]$$

(Begin section III-6.29)

6.29 TOTAL OPERATING COSTS

Variables

Defined in section III-6.4
qt = qualified technology types.

Defined in section III-6.18
LABOR[qt] = annual labor cost for technology type **qt** ($/yr).

Defined in section III-6.19
MAINT[qt] = annual maintenance cost for technology type **qt** ($/yr).

Defined in section III-6.20
FUEL[qt] = annual fuel cost for technology type **qt** ($/yr).

Defined in section III-6.21
POWER[qt] = annual power cost for technology type **qt** ($/yr).

Defined in section III-6.25
TOTOCAPC[qt] = total operational air pollution control cost for technology type **qt** ($/yr).

Defined in section III-6.26
WASTE[qt] = the annual cost of waste disposal for technology type **qt** ($/yr).

Defined in section III-6.27
TAXINS[qt] = annual taxes and insurance for technology type **qt** ($/yr).

Defined in section III-6.28
WATER[qt] = annual water cost for technology type **qt** ($/yr).

Calculated in this section
TOTALOPCOST[qt] = total annual operating cost for technology type **qt** ($/yr).
NONFUELOPCOST[qt] = annual non-fuel operating cost for technology type **qt** ($/yr).
NONLABO&MCOST[qt] = annual non-labor O&M cost for technology type **qt** ($/yr).

Calculations

For each qualified technology, **qt**, do the following.

TOTOPERCOST[qt] = **LABOR[qt]** + **MAINT[qt]** + **FUEL[qt]** + **POWER[qt]** + **WASTE[qt]** + **TOTOCAPC[qt]** + **TAXINS[qt]** + **WATER[qt]**

NONFUELOPCOST[qt] = **TOTOPERCOST[qt]** - **FUEL[qt]**

NONLABO&MCOST[qt] = **MAINT[qt]** + **POWER[qt]** + **TAXINS[qt]** + **WATER[qt]**

(Begin section III-6.30)

6.30 HPCALC REPORTS

Figures III-2 through III-8 identify the origins of the data contained in the seven reports generated by HPCALC. Boldface type indicates variables defined in sections III-6.1 through III-6.29.

Note that all cost variables are calculated in U.S. dollars. (They do not reflect a conversion to Deutsche marks.)

```
**************************************************************************
**                            COST SUMMARY                              **
**                                                                      **
**   Title: <title>                       Date: mm/dd/year              **
**   User : <user>                        Basic Data:   <hpdata>.CDA    **
**   DM conversion: (None // x.xx)    HEATLOAD File : <heatload>.HDA    **
**************************************************************************
*** Cost Summary for Technology Type qt   (IN DOLLARS // IN DEUTSCHE MARKS)

CAPITAL COST                             ANNUAL OPERATING COST
Purchased Equipment.... =       PEC[qt]  Labor............. =     LABOR[qt]
Balance of Plant....... =       BOP[qt]  Maintenance....... =     MAINT[qt]
Air Pol. Control (Part) =      PAPC[qt]  Fuel.............. =      FUEL[qt]
Air Pol. Control (SO2). =      SAPC[qt]  Water Treatment    =     WATER[qt]
Retrofit Adjustment.... =       RET[qt]  Power............. =     POWER[qt]
                          -------------  APC (part)........ =    OCPAPC[qt]
Total Direct Cap. Cost. = TOTASSETS[qt]  APC (SO2)......... =    OCSAPC[qt]
                                         Waste Disposal.... =     WASTE[qt]
Engr,Des,Constr Mgmt @ PCTEDC = EDC[qt]  Taxes, Ins etc.... =    TAXINS[qt]
                          -------------
Subtotal...... = TOTASSETS[qt] + EDC[qt]

Contingency @ PCTCONTIN =    CONTIN[qt]
                          -------------                      --------------
Total Capital Cost..... = TOTCAPCOST[qt] Total Oper Cost = TOTOPERCOST[qt]
```

Figure III-2. The origins of COST SUMMARY report entries.

```
****************************************************************************
**                              RUN DATA                                  **
**                                                                        **
**   Title: <title>                         Date: mm/dd/year              **
**   User : <user>                          Basic Data:    <hpdata>.CDA   **
**   DM conversion: (None // x.xx)      HEATLOAD File : <heatload>.HDA    **
****************************************************************************

Basic data file used = C:\HPDATA\<hpdata>.CDA
HEATLOAD file = (C:\HEATLOAD\<heatload>.HDA // not used)
Climate Region = (<region name> // NA)
Estimated or HEATLOAD loads used = (HEATLOAD // estimated)
Steam or hot water system    =  (steam // hot water)
Percent condensate returned =  (PCTCOND // NA)
Backup configuration used    =  (Extra Boiler // Oversized Boiler)
Retrofit Project             =  (No // Yes)
Particulate control          =  (None // Baghouse // ESP // <name>)
SO2 control                  =  (None // Dry Scubber w/ Baghouse // <name>)
Study date          (DOS) : mon year
Start of constr.    (SOC) : mon year
Beneficial Occup. (BOD) : mon year
Deutsche Mark Exchange Rate    =  (NA // x.xx)
```

Figure III-3. The origins of RUN DATA report entries.

```
****************************************************************************
**                         ECONOMIC SUMMARY                               **
**                                                                        **
**   Title: <title>                         Date: mm/dd/year              **
**   User : <user>                          Basic Data:    <hpdata>.CDA   **
**   DM conversion: (None // x.xx)      HEATLOAD File : <heatload>.HDA    **
****************************************************************************

VALUES ARE (IN DOLLARS // IN DEUTSCHE MARKS)


                            TOTAL          ANNUAL NON-FUEL      ANNUAL FUEL
TYPE TECHNOLOGY         CAPITAL COST       OPERATING COST    OPERATING COST

     qt                TOTCAPCOST[qt]     NONFUELOPCOST[qt]        FUEL[qt]
```

Figure III-4. The origins of ECONOMIC SUMMARY report entries.

```
*************************************************************************
**                        DEMAND DATA SUMMARY                           **
**                                                                      **
**   Title: <title>                       Date: mm/dd/year              **
**   User : <user>                        Basic Data:   <hpdata>.CDA    **
**   DM conversion: (None // x.xx)     HEATLOAD File : <heatload>.HDA   **
*************************************************************************
Backup factor ...... =        BACKUPFAC
Total capacity ..... =        TOTPLANTCAP
Max Boiler steam.... =        BOILERSTEAM
Max Load ........... =        MAXLOAD
Min Load ........... =        MINLOAD
Avg Load ........... =        AVGLOAD
Avg Availability.... =        average of {AVAIL[qt]*100%}
                                          For all qt

Boiler configuration (appears as one of the following):
  1)  Size "A":       NUMBOILERS  at  REGBOILCAP
      Size "B":                0  at  0.00 MBtu/hr

  2)  Size "A":                1  at  SMLBOILCAP
      Size "B":   NUMBOILERS - 1  at  REGBOILCAP
```

Figure III-5. The origins of DEMAND DATA SUMMARY report entries.

```
*************************************************************************
**                      TECHNOLOGY DATA SUMMARY                         **
**                                                                      **
**   Title: <title>                       Date: mm/dd/year              **
**   User : <user>                        Basic Data:   <hpdata>.CDA    **
**   DM conversion: (None // x.xx)     HEATLOAD File : <heatload>.HDA   **
*************************************************************************

 TYPE OF            TYPE            LIFE          EFF           AVAIL
 TECHNOLOGY         FUEL             YRS           %              %

 tt (= qt)      FUELTYPE[qt]    asset_life*    EFF[qt]      AVAIL[qt]*100%

 tt (<> qt)     Technology outside capacity range**
                (REGBOILCAP  vs  MINBOILER[tt] to MAXBOILER[tt])
```

Figure III-6. The origins of TECHNOLOGY DATA SUMMARY report entries.

[*] Note: The variable "asset_life" is stored in HPDATA under TECHNOLOGY TYPES.

[**] Note. For technologies listing "Technology outside capacity range", calculated boiler capacities are compared to the minimum and maximum capacities for which the cost data are valid.

```
*****************************************************************************
**                         CAPITAL COST SUMMARY                            **
**                                                                         **
**   Title: <title>                           Date: mm/dd/year             **
**   User : <user>                            Basic Data:   <hpdata>.CDA   **
**   DM conversion: (None // x.xx)       HEATLOAD File : <heatload>.HDA    **
*****************************************************************************

VALUES ARE (IN DOLLARS // IN DEUTSCHE MARKS)


TYPE   PRIMARY   BALANCE      OTHER       EDC        CONT          TOTAL
TECH   EQ COST  PLANT COST    COSTS        %          %            COSTS

 qt    PEC[qt]   BOP[qt]    TOTAPC[qt]  PCTEDC   PCTCONTIN   TOTCAPCOST[qt]
                             + RET[qt]

       EDC = engineering, design, construction mgmt.
      CONT = allowance for contingencies
     OTHER = air pollution control + retrofit (if any)
```

Figure III-7. The origins of CAPITAL COST SUMMARY report entries.

```
*****************************************************************************
**                        OPERATING COST SUMMARY                           **
**                                                                         **
**   Title: <title>                           Date: mm/dd/year             **
**   User : <user>                            Basic Data:   <hpdata>.CDA   **
**   DM conversion: (None // x.xx)       HEATLOAD File : <heatload>.HDA    **
*****************************************************************************

VALUES ARE (IN DOLLARS // IN DEUTSCHE MARKS)


TYPE        O&M              FUEL        APC          LABOR          TOTAL
TECH        COST             COST        COST          COST           COST

 qt  NONLABO&MCOST[qt]  FUEL[qt]  TOTOCAPC[qt]  LABOR[qt]   TOTOPERCOST[qt]
                                  + WASTE[qt]


          O & M Cost = maintenance + water + power + taxes + insurance
          APC Cost = air pollution control + waste disposal
```

Figure III-8. The origins of OPERATING COST SUMMARY report entries.

6.31 LCCID Input File Created By HPCALC

Table III-4 lists the contents of an LCCID input file created by HPCALC. Boldface type indicates variables passed from HPCALC.* In creating the LCCID input file, HPCALC makes the following assumptions:

1. The study period is 25 years unless the user changes the asset life.
2. Cash flows are automatically discounted at 7 percent.
3. Capital costs occur at the midpoint of construction.
4. When "wood" is selected as the fuel type, its future cost is calculated using the price escalation rates assigned for coal.
5. When the "Option 1" fuel type is selected, its future cost is calculated using the price escalation rates assigned for residual fuel oil (#6 oil).

To run LCCID using different assumptions, the user must modify the ".LC" file created by LCCID. (See section II-3.4 for a brief description of the ".LC" file, or refer to the LCCID User's Manual.)

* Note: All cost variables are passed to LCCID in U.S. dollars.

Table III-4
The LCCID Input File created by HPCALC

Data	**Description/Units**	**Type**	**Reference**
N	Instructions?	fixed	LCCID Manual
study_name	name of study	variable	entered in HPCALC
Y	New LCC Study?	fixed	LCCID Manual
<Enter>	No LCC Study code	fixed	LCCID Manual
S	Select Study Parameters	fixed	LCCID Manual
1	Military Construction Army	fixed	LCCID Manual
Y	energy consumption values entered	fixed	LCCID Manual
Y	Non-ECIP Study	fixed	LCCID Manual
2	Non-Solar Design	fixed	LCCID Manual
D	Select Key Study Dates	fixed	LCCID Manual
DOS	date of study (month year)	variable	Section III-6.30, Run Data
midpoint of (**SOC** and **BOD**)	midpt of constr (month year)	variable	Section III-6.30, Run Data
BOD	beneficial occupancy (month year)	variable	Section III-6.30, Run Data
asset_life	economic life of building	variable	HPDATA, Technology Types

Table III-4 (cont'd)
The LCCID Input File created by HPCALC

Data	Description/Units	Type	Reference
Y	accepts previously entered data	fixed	LCCID Manual
<Enter>	exit Select Key Study Dates	fixed	LCCID Manual
M	Select Dollar Input Multiplier	fixed	LCCID Manual
1	Costs/Benefits in Thousands of $'s	fixed	LCCID Manual
E	Energy Related Study Inputs	fixed	LCCID Manual
S	Select Location	fixed	LCCID Manual
state	study location	variable	entered in HPCALC
Y	accepts previously entered data	fixed	LCCID Manual
<Enter>	use most current escalation rates	fixed	LCCID Manual
K	Select Energy Input Multiplier	fixed	LCCID Manual
2	Input in Millions of Btu's	fixed	LCCID Manual
P	Select Energy Prices	fixed	LCCID Manual
com	fuel type expressed as an integer	variable	Section III-6.20, and LCCID Manual
$\frac{\mathbf{FUELCOST}[\mathbf{com}] * (1{,}000{,}000\ \mathrm{Btu/MBtu})}{\mathbf{HHV}[\mathbf{qt}] * \mathbf{CONV}[\mathbf{qt}]}$	cost of fuel ($/MBtu)	variable	Section III-6.20
<Enter>	exit Select Energy Prices	fixed	LCCID Manual
<Enter>	exit Select Energy Related Study Input	fixed	LCCID Manual

Table III-4 (cont'd)
The LCCID Input File created by HPCALC

Data	Description/Units	Type	Reference
T	Select Study Identification Block	fixed	LCCID Manual
project_number	project number	variable	entered in HPCALC
SOC	2 digit fiscal year of project	variable	Section III-6.30, Run Data
project_title	project title	variable	entered in HPCALC
installation_name	name of installation	variable	entered in HPCALC
name	name of person preparing study	variable	entered in HPCALC
design_feature	design feature of study	variable	entered in HPCALC
<Enter>	exit Select Study Ident. Block	fixed	LCCID Manual
<Enter>	exit Select Study Parameters	fixed	LCCID Manual
A	Define/Change Alternatives	fixed	LCCID Manual
S	Define/Change Alternative Values	fixed	LCCID Manual
a	alternative identifier	fixed	LCCID Manual
technology_type	alternative title	variable	selected in HPCALC
v	Specify Initial Investment Costs	fixed	LCCID Manual
TOTCAPCOST[gt] 1,000	total capital cost	variable	Sections III-6.6 and III-6.16
<Enter>	costs occur at midpt. of construction	fixed	LCCID Manual

Table III-4 (cont'd)
The LCCID Input File created by HPCALC

Data	Description/Units	Type	Reference
E	Specify Energy Usage Values	fixed	LCCID Manual
ANNLOAD / **EFF**[**qt**]/100%	energy consumption (MBtu/yr)	variable	Sections III-6.1 and III-6.20
Y	consumption throughout analysis period	fixed	LCCID Manual
<Enter>	exit Specify Energy Usage Values	fixed	LCCID Manual
M	Specify M&R and Custodial Costs	fixed	LCCID Manual
S	Define/Change Annual Values	fixed	LCCID Manual
0 (zero)	to define a new annual value	fixed	LCCID Manual
Labor	Annual Value Title	fixed	LCCID Manual
LABOR[**qt**]/1,000	labor cost	variable	Section III-6.18
S	Define/Change Annual Values	fixed	LCCID Manual
0 (zero)	to define a new annual value	fixed	LCCID Manual
Air Poll Cntr	Annual Value Title	fixed	LCCID Manual
(**TOTOCAPC**[**qt**] + **WASTE**[**qt**])/1,000	air pollution control cost	variable	Sections III-6.25 and III-6.26
S	Define/Change Annual Values	fixed	LCCID Manual
0 (zero)	to define a new annual value	fixed	LCCID Manual

Table III-4 (cont'd)
The LCCID Input File created by HPCALC

Data	Description/Units	Type	Reference
Maint, Power, Other	Annual Value Title	fixed	LCCID Manual
NONLABO&MCOST[qt] 1,000	nonlabor O & M cost	variable	Section III-6.29
<Enter>	exit Specify Annual Values	fixed	LCCID Manual
<Enter>	exit Define/Change Alternative Values	fixed	LCCID Manual
<Enter>	exit Define/Change Alternatives	fixed	LCCID Manual
c	Calculate & Report Life Cycle Costs	fixed	LCCID Manual
i	Individual Alternative Summary Reports	fixed	LCCID Manual
a	alternative identifier	fixed	LCCID Manual
n	do not send report to screen	fixed	LCCID Manual
n	do not send report to printer	fixed	LCCID Manual
Y	send report to standard file	fixed	LCCID Manual
<Enter>	file saved as **study_name**.LCI	fixed	LCCID Manual
Y	display escalation values	fixed	LCCID Manual
Y	display yearly values	fixed	LCCID Manual
<Enter>	exit Calc/Report Life Cycle Costs	fixed	LCCID Manual
<Enter>	exit Program	fixed	LCCID Manual

APPENDIX A: CERLDATA.CDA

The file CERLDATA.CDA, as received by the user, contains a complete set of data. Figures A-1 through A-7 present a listing of this file.

Values for file: CERLDATA.CDA (Fuel Data)

Fuel Type	Parameter	Units	Current	Default	Minimum	Maximum
No 2 Oil - 1	HHV.........	Btu/unit	19126.800	19126.800	18000.000	20000.000
No 2 Oil - 1	Conversion Factor...		7.215	7.215	6.000	8.000
No 2 Oil - 1	Sulfur........	% ...	0.220	0.220	0.000	1.000
No 2 Oil - 1	Ash............	%....	0.000	0.000	0.000	1.000
No 2 Oil - 1	Moisture......	% ...	0.000	0.000	0.000	0.500
No 6 Oil - 2	HHV.........	Btu/unit	18566.000	18566.000	17000.000	20000.000
No 6 Oil - 2	Conversion Factor...		8.187	8.187	7.000	9.000
No 6 Oil - 2	Sulfur........	% ...	0.840	0.840	0.000	4.000
No 6 Oil - 2	Ash............	%....	0.040	0.040	0.000	1.000
No 6 Oil - 2	Moisture......	% ...	0.000	0.000	0.000	2.000
Nat Gas - 3	HHV.........	Btu/unit	1000.000	1000.000	800.000	1200.000
Nat Gas - 3	Conversion Factor...		1000.000	1000.000	1000.000	1000.000
Nat Gas - 3	Sulfur........	% ...	0.000	0.000	0.000	0.000
Nat Gas - 3	Ash............	%....	0.000	0.000	0.000	0.000
Nat Gas - 3	Moisture......	% ...	0.000	0.000	0.000	0.000
Coal - 4	HHV.........	Btu/unit	13560.000	13560.000	8000.000	15000.000
Coal - 4	Conversion Factor...		2000.000	2000.000	2000.000	2000.000
Coal - 4	Sulfur........	% ...	1.600	1.600	0.000	6.000
Coal - 4	Ash............	%....	7.800	7.800	5.000	15.000
Coal - 4	Moisture......	% ...	2.400	2.400	0.000	15.000
Wood - 5	HHV.........	Btu/unit	6300.000	6300.000	4000.000	8000.000
Wood - 5	Conversion Factor...		2000.000	2000.000	2000.000	2000.000
Wood - 5	Sulfur........	% ...	0.000	0.000	0.000	0.500
Wood - 5	Ash............	%....	1.000	1.000	0.000	10.000
Wood - 5	Moisture......	% ...	24.000	24.000	5.000	60.000
Option 1 - 6	HHV.........	Btu/unit	18091.800	18091.800	0.000	20000.000
Option 1 - 6	Conversion Factor...		8.081	8.081	6.000	9.000
Option 1 - 6	Sulfur........	% ...	3.970	3.970	0.000	6.000
Option 1 - 6	Ash............	%....	0.020	0.020	0.000	5.000
Option 1 - 6	Moisture......	% ...	0.000	0.000	0.000	5.000

Figure A-1. Fuel data stored in CERLDATA.CDA.

Values for file: CERLDATA.CDA (Technology Types)

Tech Type	Parameter Units	Current	Default	Minimum	Maximum
Coal-Sto ft:s	Size ....MBtu/hr.	10.000	10.000	5.000	20.000
Coal-Sto ft:s	Fuel Type.. (#)	4.000	4.000	4.000	4.000
Coal-Sto ft:s	Efficiency.... % ...	75.000	75.000	70.000	80.000
Coal-Sto ft:s	Parasitic Load.. % .	0.600	0.600	0.000	10.000
Coal-Sto ft:s	Not Used...........	0.000	0.000	0.000	0.000
Coal-Sto ft:s	Asset Life...yrs....	25.000	25.000	20.000	25.000
Coal-Sto ft:s	Forced Outage Rate.%	14.400	14.400	10.000	20.000
Coal-Sto ft:s	Planned Outage Rate%	3.800	3.800	2.000	5.000
Coal-Sto ft:s	Op Labor - men/shift	2.000	2.000	1.000	5.000
Coal-Sto ft:s	Super Labor- men/day	1.000	1.000	1.000	5.000
Coal-Sto ft:s	Maint cost-% CE cost	2.500	2.500	0.000	5.000
Coal-Sto ft:s	Unit mult for op lab	0.750	0.750	0.000	1.000

Tech Type	Parameter Units	Current	Default	Minimum	Maximum
Coal-Sto wt:s	Size ....MBtu/hr.	30.000	30.000	10.000	50.000
Coal-Sto wt:s	Fuel Type.. (#)	4.000	4.000	4.000	4.000
Coal-Sto wt:s	Efficiency.... % ...	75.000	75.000	70.000	80.000
Coal-Sto wt:s	Parasitic Load.. % .	0.600	0.600	0.000	10.000
Coal-Sto wt:s	Not Used...........	0.000	0.000	0.000	0.000
Coal-Sto wt:s	Asset Life...yrs....	25.000	25.000	25.000	25.000
Coal-Sto wt:s	Forced Outage Rate.%	14.400	14.400	10.000	20.000
Coal-Sto wt:s	Planned Outage Rate%	3.800	3.800	2.000	5.000
Coal-Sto wt:s	Op Labor - men/shift	2.000	2.000	1.000	5.000
Coal-Sto wt:s	Super Labor- men/day	1.000	1.000	0.000	5.000
Coal-Sto wt:s	Maint cost-% CE cost	2.500	2.500	0.000	5.000
Coal-Sto wt:s	Unit mult for op lab	0.750	0.750	0.000	1.000

Tech Type	Parameter Units	Current	Default	Minimum	Maximum
#6 Oil ft:s	Size ....MBtu/hr.	15.000	15.000	5.000	20.000
#6 Oil ft:s	Fuel Type.. (#)	2.000	2.000	2.000	2.000
#6 Oil ft:s	Efficiency.... % ...	80.000	80.000	75.000	85.000
#6 Oil ft:s	Parasitic Load.. % .	0.300	0.300	0.000	10.000
#6 Oil ft:s	Not Used...........	0.000	0.000	0.000	0.000
#6 Oil ft:s	Asset Life...yrs....	25.000	25.000	25.000	25.000
#6 Oil ft:s	Forced Outage Rate.%	4.800	4.800	3.000	10.000
#6 Oil ft:s	Planned Outage Rate%	3.800	3.800	2.000	5.000
#6 Oil ft:s	Op Labor - men/shift	1.000	1.000	1.000	5.000
#6 Oil ft:s	Super Labor- men/day	1.000	1.000	1.000	5.000
#6 Oil ft:s	Maint cost-% CE cost	2.500	2.500	0.000	5.000
#6 Oil ft:s	Unit mult for op lab	0.750	0.750	0.000	1.000

Figure A-2. Technology data stored in CERLDATA.CDA.

Values for file: CERLDATA.CDA (Technology Types)

Tech Type		Parameter Units	Current	Default	Minimum	Maximum
#6 Oil	wt:s	Size ....MBtu/hr.	35.000	35.000	25.000	50.000
#6 Oil	wt:s	Fuel Type.. (#)	2.000	2.000	2.000	2.000
#6 Oil	wt:s	Efficiency.... % ...	80.000	80.000	75.000	85.000
#6 Oil	wt:s	Parasitic Load.. % .	0.300	0.300	0.000	10.000
#6 Oil	wt:s	Not Used...........	0.000	0.000	0.000	0.000
#6 Oil	wt:s	Asset Life...yrs....	25.000	25.000	20.000	40.000
#6 Oil	wt:s	Forced Outage Rate.%	4.800	4.800	10.000	20.000
#6 Oil	wt:s	Planned Outage Rate%	3.800	3.800	2.000	5.000
#6 Oil	wt:s	Op Labor - men/shift	1.000	1.000	1.000	5.000
#6 Oil	wt:s	Super Labor- men/day	1.000	1.000	1.000	5.000
#6 Oil	wt:s	Maint cost-% CE cost	2.500	2.500	0.000	5.000
#6 Oil	wt:s	Unit mult for op lab	0.750	0.750	0.000	1.000

Tech Type		Parameter Units	Current	Default	Minimum	Maximum
#2 Oil	ft:w	Size ....MBtu/hr.	10.000	10.000	5.000	50.000
#2 Oil	ft:w	Fuel Type.. (#)	1.000	1.000	1.000	1.000
#2 Oil	ft:w	Efficiency.... % ...	80.000	80.000	75.000	85.000
#2 Oil	ft:w	Parasitic Load.. % .	0.300	0.300	0.000	10.000
#2 Oil	ft:w	Not Used...........	0.000	0.000	0.000	0.000
#2 Oil	ft:w	Asset Life...yrs....	25.000	25.000	15.000	30.000
#2 Oil	ft:w	Forced Outage Rate.%	4.800	4.800	3.000	10.000
#2 Oil	ft:w	Planned Outage Rate%	3.800	3.800	2.000	5.000
#2 Oil	ft:w	Op Labor - men/shift	1.000	1.000	1.000	5.000
#2 Oil	ft:w	Super Labor- men/day	1.000	1.000	1.000	5.000
#2 Oil	ft:w	Maint cost-% CE cost	2.500	2.500	0.000	5.000
#2 Oil	ft:w	Unit mult for op lab	0.750	0.750	0.000	1.000

Tech Type		Parameter Units	Current	Default	Minimum	Maximum
#2 Oil	ft:s	Size ....MBtu/hr.	15.000	15.000	5.000	25.000
#2 Oil	ft:s	Fuel Type.. (#)	1.000	1.000	1.000	1.000
#2 Oil	ft:s	Efficiency.... % ...	80.000	80.000	75.000	85.000
#2 Oil	ft:s	Parasitic Load.. % .	0.300	0.300	0.000	10.000
#2 Oil	ft:s	Not Used...........	0.000	0.000	0.000	0.000
#2 Oil	ft:s	Asset Life...yrs....	25.000	25.000	25.000	25.000
#2 Oil	ft:s	Forced Outage Rate.%	4.800	4.800	3.000	10.000
#2 Oil	ft:s	Planned Outage Rate%	3.800	3.800	2.000	5.000
#2 Oil	ft:s	Op Labor - men/shift	1.000	1.000	1.000	5.000
#2 Oil	ft:s	Super Labor- men/day	1.000	1.000	1.000	5.000
#2 Oil	ft:s	Maint cost-% CE cost	2.500	2.500	0.000	5.000
#2 Oil	ft:s	Unit mult for op lab	0.750	0.750	0.000	1.000

Figure A-2 (cont'd).

Values for file: CERLDATA.CDA (Technology Types)

Tech Type		Parameter Units	Current	Default	Minimum	Maximum
#2 Oil	wt:s	Size ....MBtu/hr.	35.000	35.000	25.000	50.000
#2 Oil	wt:s	Fuel Type.. (#)	1.000	1.000	1.000	1.000
#2 Oil	wt:s	Efficiency.... % ...	80.000	80.000	75.000	85.000
#2 Oil	wt:s	Parasitic Load.. % .	0.300	0.300	0.000	10.000
#2 Oil	wt:s	Not Used...........	0.000	0.000	0.000	0.000
#2 Oil	wt:s	Asset Life...yrs....	25.000	25.000	20.000	40.000
#2 Oil	wt:s	Forced Outage Rate.%	4.800	4.800	3.000	10.000
#2 Oil	wt:s	Planned Outage Rate%	3.800	3.800	2.000	5.000
#2 Oil	wt:s	Op Labor - men/shift	1.000	1.000	1.000	5.000
#2 Oil	wt:s	Super Labor- men/day	1.000	1.000	1.000	5.000
#2 Oil	wt:s	Maint cost-% CE cost	2.500	2.500	0.000	5.000
#2 Oil	wt:s	Unit mult for op lab	0.750	0.750	0.000	1.000

Tech Type		Parameter Units	Current	Default	Minimum	Maximum
Nat Gas	ft:w	Size ....MBtu/hr.	10.000	10.000	5.000	50.000
Nat Gas	ft:w	Fuel Type.. (#)	3.000	3.000	3.000	3.000
Nat Gas	ft:w	Efficiency.... % ...	78.000	78.000	73.000	83.000
Nat Gas	ft:w	Parasitic Load.. % .	0.300	0.300	0.000	10.000
Nat Gas	ft:w	Not Used...........	0.000	0.000	0.000	0.000
Nat Gas	ft:w	Asset Life...yrs....	25.000	25.000	15.000	25.000
Nat Gas	ft:w	Forced Outage Rate.%	4.800	4.800	3.000	10.000
Nat Gas	ft:w	Planned Outage Rate%	3.800	3.800	2.000	5.000
Nat Gas	ft:w	Op Labor - men/shift	1.000	1.000	1.000	5.000
Nat Gas	ft:w	Super Labor- men/day	1.000	1.000	1.000	5.000
Nat Gas	ft:w	Maint cost-% CE cost	2.500	2.500	0.000	5.000
Nat Gas	ft:w	Unit mult for op lab	0.750	0.750	0.000	1.000

Tech Type		Parameter Units	Current	Default	Minimum	Maximum
Nat Gas	ft:s	Size ....MBtu/hr.	15.000	15.000	5.000	25.000
Nat Gas	ft:s	Fuel Type.. (#)	3.000	3.000	3.000	3.000
Nat Gas	ft:s	Efficiency.... % ...	78.000	78.000	73.000	83.000
Nat Gas	ft:s	Parasitic Load.. % .	0.300	0.300	0.000	10.000
Nat Gas	ft:s	Not Used...........	0.000	0.000	0.000	0.000
Nat Gas	ft:s	Asset Life...yrs....	25.000	25.000	25.000	25.000
Nat Gas	ft:s	Forced Outage Rate.%	4.800	4.800	3.000	10.000
Nat Gas	ft:s	Planned Outage Rate%	3.800	3.800	2.000	5.000
Nat Gas	ft:s	Op Labor - men/shift	1.000	1.000	1.000	5.000
Nat Gas	ft:s	Super Labor- men/day	1.000	1.000	1.000	5.000
Nat Gas	ft:s	Maint cost-% CE cost	2.500	2.500	0.000	5.000
Nat Gas	ft:s	Unit mult for op lab	0.750	0.750	0.000	1.000

Figure A-2 (cont'd).

Values for file: CERLDATA.CDA (Technology Types)

Tech Type		Parameter Units	Current	Default	Minimum	Maximum
Nat Gas	wt:s	Size ....MBtu/hr.	35.000	35.000	25.000	50.000
Nat Gas	wt:s	Fuel Type.. (#)	3.000	3.000	3.000	3.000
Nat Gas	wt:s	Efficiency.... % ...	78.000	78.000	73.000	83.000
Nat Gas	wt:s	Parasitic Load.. % .	0.300	0.300	0.000	10.000
Nat Gas	wt:s	Not Used...........	0.000	0.000	0.000	0.000
Nat Gas	wt:s	Asset Life...yrs....	25.000	25.000	25.000	25.000
Nat Gas	wt:s	Forced Outage Rate.%	4.800	4.800	3.000	10.000
Nat Gas	wt:s	Planned Outage Rate%	3.800	3.800	2.000	5.000
Nat Gas	wt:s	Op Labor - men/shift	1.000	1.000	1.000	5.000
Nat Gas	wt:s	Super Labor- men/day	1.000	1.000	1.000	5.000
Nat Gas	wt:s	Maint cost-% CE cost	2.500	2.500	0.000	5.000
Nat Gas	wt:s	Unit mult for op lab	0.750	0.750	0.000	1.000

Tech Type		Parameter Units	Current	Default	Minimum	Maximum
Wood	wt:s	Size ....MBtu/hr.	30.000	30.000	10.000	50.000
Wood	wt:s	Fuel Type.. (#)	5.000	5.000	5.000	5.000
Wood	wt:s	Efficiency.... % ...	71.000	71.000	66.000	76.000
Wood	wt:s	Parasitic Load.. % .	0.600	0.600	0.000	10.000
Wood	wt:s	Not Used...........	0.000	0.000	0.000	0.000
Wood	wt:s	Asset Life...yrs....	25.000	25.000	25.000	25.000
Wood	wt:s	Forced Outage Rate.%	14.400	14.400	10.000	20.000
Wood	wt:s	Planned Outage Rate%	3.800	3.800	2.000	5.000
Wood	wt:s	Op Labor - men/shift	2.000	2.000	1.000	5.000
Wood	wt:s	Super Labor- men/day	1.000	1.000	1.000	5.000
Wood	wt:s	Maint cost-% CE cost	2.500	2.500	0.000	5.000
Wood	wt:s	Unit mult for op lab	0.750	0.750	0.000	1.000

Tech Type		Parameter Units	Current	Default	Minimum	Maximum
Gas/2Oil	ft:w	Size ....MBtu/hr.	10.000	10.000	5.000	50.000
Gas/2Oil	ft:w	Fuel Type.. (#)	3.000	3.000	3.000	3.000
Gas/2Oil	ft:w	Efficiency.... % ...	78.000	78.000	73.000	83.000
Gas/2Oil	ft:w	Parasitic Load.. % .	0.300	0.300	0.000	10.000
Gas/2Oil	ft:w	Not Used...........	0.000	0.000	0.000	0.000
Gas/2Oil	ft:w	Asset Life...yrs....	25.000	25.000	15.000	30.000
Gas/2Oil	ft:w	Forced Outage Rate.%	4.800	4.800	3.000	10.000
Gas/2Oil	ft:w	Planned Outage Rate%	3.800	3.800	2.000	5.000
Gas/2Oil	ft:w	Op Labor - men/shift	1.000	1.000	1.000	5.000
Gas/2Oil	ft:w	Super Labor- men/day	1.000	1.000	1.000	5.000
Gas/2Oil	ft:w	Maint cost-% CE cost	2.500	2.500	0.000	5.000
Gas/2Oil	ft:w	Unit mult for op lab	0.750	0.750	0.000	1.000

Figure A-2 (cont'd).

Values for file: CERLDATA.CDA (Technology Types)

Tech Type	Parameter Units	Current	Default	Minimum	Maximum
Gas/2Oil ft:s	Size ....MBtu/hr.	15.000	15.000	5.000	25.000
Gas/2Oil ft:s	Fuel Type.. (#)	3.000	3.000	3.000	3.000
Gas/2Oil ft:s	Efficiency.... % ...	78.000	78.000	73.000	83.000
Gas/2Oil ft:s	Parasitic Load.. % .	0.300	0.300	0.000	10.000
Gas/2Oil ft:s	Not Used...........	0.000	0.000	0.000	0.000
Gas/2Oil ft:s	Asset Life...yrs....	25.000	25.000	25.000	25.000
Gas/2Oil ft:s	Forced Outage Rate.%	4.800	4.800	3.000	10.000
Gas/2Oil ft:s	Planned Outage Rate%	3.800	3.800	2.000	5.000
Gas/2Oil ft:s	Op Labor - men/shift	1.000	1.000	1.000	5.000
Gas/2Oil ft:s	Super Labor- men/day	1.000	1.000	1.000	5.000
Gas/2Oil ft:s	Maint cost-% CE cost	2.500	2.500	0.000	5.000
Gas/2Oil ft:s	Unit mult for op lab	0.750	0.750	0.000	1.000

Tech Type	Parameter Units	Current	Default	Minimum	Maximum
Gas/2Oil wt:s	Size ....MBtu/hr.	35.000	35.000	25.000	50.000
Gas/2Oil wt:s	Fuel Type.. (#)	3.000	3.000	3.000	3.000
Gas/2Oil wt:s	Efficiency.... % ...	78.000	78.000	73.000	83.000
Gas/2Oil wt:s	Parasitic Load.. % .	0.300	0.300	0.000	10.000
Gas/2Oil wt:s	Not Used...........	0.000	0.000	0.000	0.000
Gas/2Oil wt:s	Asset Life...yrs....	25.000	25.000	20.000	40.000
Gas/2Oil wt:s	Forced Outage Rate.%	4.800	4.800	3.000	10.000
Gas/2Oil wt:s	Planned Outage Rate%	3.800	3.800	2.000	5.000
Gas/2Oil wt:s	Op Labor - men/shift	1.000	1.000	1.000	5.000
Gas/2Oil wt:s	Super Labor- men/day	1.000	1.000	1.000	5.000
Gas/2Oil wt:s	Maint cost-% CE cost	2.500	2.500	0.000	5.000
Gas/2Oil wt:s	Unit mult for op lab	0.750	0.750	0.000	1.000

Tech Type	Parameter Units	Current	Default	Minimum	Maximum
2Oil/Gas ft:w	Size ....MBtu/hr.	10.000	10.000	5.000	50.000
2Oil/Gas ft:w	Fuel Type.. (#)	1.000	1.000	1.000	1.000
2Oil/Gas ft:w	Efficiency.... % ...	80.000	80.000	75.000	85.000
2Oil/Gas ft:w	Parasitic Load.. % .	0.300	0.300	0.000	10.000
2Oil/Gas ft:w	Not Used...........	0.000	0.000	0.000	0.000
2Oil/Gas ft:w	Asset Life...yrs....	25.000	25.000	15.000	30.000
2Oil/Gas ft:w	Forced Outage Rate.%	4.800	4.800	3.000	10.000
2Oil/Gas ft:w	Planned Outage Rate%	3.800	3.800	2.000	5.000
2Oil/Gas ft:w	Op Labor - men/shift	1.000	1.000	1.000	5.000
2Oil/Gas ft:w	Super Labor- men/day	1.000	1.000	1.000	5.000
2Oil/Gas ft:w	Maint cost-% CE cost	2.500	2.500	0.000	5.000
2Oil/Gas ft:w	Unit mult for op lab	0.750	0.750	0.000	1.000

Figure A-2 (cont'd).

Values for file: CERLDATA.CDA (Technology Types)

Tech Type	Parameter Units	Current	Default	Minimum	Maximum
2Oil/Gas ft:s	Size ....MBtu/hr.	15.000	15.000	5.000	25.000
2Oil/Gas ft:s	Fuel Type.. (#)	1.000	1.000	1.000	1.000
2Oil/Gas ft:s	Efficiency.... % ...	80.000	80.000	75.000	85.000
2Oil/Gas ft:s	Parasitic Load.. % .	0.300	0.300	0.000	10.000
2Oil/Gas ft:s	Not Used...........	0.000	0.000	0.000	0.000
2Oil/Gas ft:s	Asset Life...yrs....	25.000	25.000	25.000	25.000
2Oil/Gas ft:s	Forced Outage Rate.%	4.800	4.800	3.000	10.000
2Oil/Gas ft:s	Planned Outage Rate%	3.800	3.800	2.000	5.000
2Oil/Gas ft:s	Op Labor - men/shift	1.000	1.000	1.000	5.000
2Oil/Gas ft:s	Super Labor- men/day	1.000	1.000	1.000	5.000
2Oil/Gas ft:s	Maint cost-% CE cost	2.500	2.500	0.000	5.000
2Oil/Gas ft:s	Unit mult for op lab	0.750	0.750	0.000	1.000

Tech Type	Parameter Units	Current	Default	Minimum	Maximum
2Oil/Gas wt:s	Size ....MBtu/hr.	35.000	35.000	25.000	50.000
2Oil/Gas wt:s	Fuel Type.. (#)	1.000	1.000	1.000	1.000
2Oil/Gas wt:s	Efficiency.... % ...	80.000	80.000	75.000	85.000
2Oil/Gas wt:s	Parasitic Load.. % .	0.300	0.300	0.000	10.000
2Oil/Gas wt:s	Not Used...........	0.000	0.000	0.000	0.000
2Oil/Gas wt:s	Asset Life...yrs....	25.000	25.000	20.000	40.000
2Oil/Gas wt:s	Forced Outage Rate.%	4.800	4.800	3.000	10.000
2Oil/Gas wt:s	Planned Outage Rate%	3.800	3.800	2.000	5.000
2Oil/Gas wt:s	Op Labor - men/shift	1.000	1.000	1.000	5.000
2Oil/Gas wt:s	Super Labor- men/day	1.000	1.000	1.000	5.000
2Oil/Gas wt:s	Maint cost-% CE cost	2.500	2.500	0.000	5.000
2Oil/Gas wt:s	Unit mult for op lab	0.750	0.750	0.000	1.000

Tech Type	Parameter Units	Current	Default	Minimum	Maximum
Other 1 ??:?	Size ....MBtu/hr.	0.000	0.000	0.000	0.000
Other 1 ??:?	Fuel Type.. (#)	0.000	0.000	0.000	0.000
Other 1 ??:?	Efficiency.... % ...	0.000	0.000	0.000	0.000
Other 1 ??:?	Parasitic Load.. % .	0.000	0.000	0.000	0.000
Other 1 ??:?	Not Used...........	0.000	0.000	0.000	0.000
Other 1 ??:?	Asset Life...yrs....	0.000	0.000	0.000	0.000
Other 1 ??:?	Forced Outage Rate.%	0.000	0.000	0.000	0.000
Other 1 ??:?	Planned Outage Rate%	0.000	0.000	0.000	0.000
Other 1 ??:?	Op Labor - men/shift	0.000	0.000	0.000	0.000
Other 1 ??:?	Super Labor- men/day	0.000	0.000	0.000	0.000
Other 1 ??:?	Maint cost-% CE cost	0.000	0.000	0.000	0.000
Other 1 ??:?	Unit mult for op lab	0.000	0.000	0.000	0.000

Figure A-2 (cont'd).

Values for file: CERLDATA.CDA (Technology Types)

Tech Type		Parameter Units	Current	Default	Minimum	Maximum
Other 2	??:?	Size ....MBtu/hr.	0.000	0.000	0.000	0.000
Other 2	??:?	Fuel Type.. (#)	0.000	0.000	0.000	0.000
Other 2	??:?	Efficiency.... % ...	0.000	0.000	0.000	0.000
Other 2	??:?	Parasitic Load.. % .	0.000	0.000	0.000	0.000
Other 2	??:?	Not Used............	0.000	0.000	0.000	0.000
Other 2	??:?	Asset Life...yrs....	0.000	0.000	0.000	0.000
Other 2	??:?	Forced Outage Rate.%	0.000	0.000	0.000	0.000
Other 2	??:?	Planned Outage Rate%	0.000	0.000	0.000	0.000
Other 2	??:?	Op Labor - men/shift	0.000	0.000	0.000	0.000
Other 2	??:?	Super Labor- men/day	0.000	0.000	0.000	0.000
Other 2	??:?	Maint cost-% CE cost	0.000	0.000	0.000	0.000
Other 2	??:?	Unit mult for op lab	0.000	0.000	0.000	0.000

Tech Type		Parameter Units	Current	Default	Minimum	Maximum
Other 3	??:?	Size ....MBtu/hr.	0.000	0.000	0.000	0.000
Other 3	??:?	Fuel Type.. (#)	0.000	0.000	0.000	0.000
Other 3	??:?	Efficiency.... % ...	0.000	0.000	0.000	0.000
Other 3	??:?	Parasitic Load.. % .	0.000	0.000	0.000	0.000
Other 3	??:?	Not Used............	0.000	0.000	0.000	0.000
Other 3	??:?	Asset Life...yrs....	0.000	0.000	0.000	0.000
Other 3	??:?	Forced Outage Rate.%	0.000	0.000	0.000	0.000
Other 3	??:?	Planned Outage Rate%	0.000	0.000	0.000	0.000
Other 3	??:?	Op Labor - men/shift	0.000	0.000	0.000	0.000
Other 3	??:?	Super Labor- men/day	0.000	0.000	0.000	0.000
Other 3	??:?	Maint cost-% CE cost	0.000	0.000	0.000	0.000
Other 3	??:?	Unit mult for op lab	0.000	0.000	0.000	0.000

Figure A-2 (cont'd).

Values for file: CERLDATA.CDA (Capital Cost Data)

Tech Type	Parameter Units	Current	Default	Minimum	Maximum
Coal-Sto ft:s	Equip Cost.a (coef)	136.490	136.490	136.490	136.490
Coal-Sto ft:s	Equip Cost.b (exp).	0.490	0.490	0.490	0.490
Coal-Sto ft:s	BOP...% equip cost.	25.000	25.000	25.000	25.000
Coal-Sto ft:s	Not Used..........	0.000	0.000	0.000	0.000
Coal-Sto ft:s	APC-Baghouse coef..	26844.000	26844.000	26844.000	26844.000
Coal-Sto ft:s	APC-SO2 cost.coef..	96120.000	96120.000	96120.000	96120.000
Coal-Sto ft:s	APC-ESP.cost.coef..	62841.000	62841.000	62841.000	62841.000
Coal-Sto ft:s	Retrofit % (of BOP)	75.000	75.000	0.000	200.000

Tech Type	Parameter Units	Current	Default	Minimum	Maximum
Coal-Sto wt:s	Equip Cost.a (coef)	121.290	121.290	121.290	121.290
Coal-Sto wt:s	Equip Cost.b (exp).	0.590	0.590	0.590	0.590
Coal-Sto wt:s	BOP..% equip cost..	25.000	25.000	25.000	25.000
Coal-Sto wt:s	Not Used..........	0.000	0.000	0.000	0.000
Coal-Sto wt:s	APC-Baghouse coef..	26844.000	26844.000	26844.000	26844.000
Coal-Sto wt:s	APC-SO2 cost.coef..	96120.000	96120.000	96120.000	96120.000
Coal-Sto wt:s	APC-ESP.cost.coef..	62841.000	62841.000	62841.000	62841.000
Coal-Sto wt:s	Retrofit % (of BOP)	75.000	75.000	0.000	200.000

Tech Type	Parameter Units	Current	Default	Minimum	Maximum
#6 Oil ft:s	Equip Cost.a (coef)	37.466	37.466	37.466	37.466
#6 Oil ft:s	Equip Cost.b (exp).	0.500	0.500	0.500	0.500
#6 Oil ft:s	BOP..% equip cost..	25.000	25.000	25.000	25.000
#6 Oil ft:s	Not Used..........	0.000	0.000	0.000	0.000
#6 Oil ft:s	APC-Baghouse coef..	26844.000	26844.000	26844.000	26844.000
#6 Oil ft:s	APC-SO2 cost.coef..	96120.000	96120.000	96120.000	96120.000
#6 Oil ft:s	APC-ESP.cost.coef..	62841.000	62841.000	62841.000	62841.000
#6 Oil ft:s	Retrofit % (of BOP)	50.000	50.000	0.000	200.000

Tech Type	Parameter Units	Current	Default	Minimum	Maximum
#6 Oil wt:s	Equip Cost.a (coef)	35.876	35.876	35.876	35.876
#6 Oil wt:s	Equip Cost.b (exp).	0.630	0.630	0.630	0.630
#6 Oil wt:s	BOP..% equip cost..	25.000	25.000	25.000	25.000
#6 Oil wt:s	Not Used..........	0.000	0.000	0.000	0.000
#6 Oil wt:s	APC-Baghouse coef..	26844.000	26844.000	26844.000	26844.000
#6 Oil wt:s	APC-SO2 cost.coef..	96120.000	96120.000	96120.000	96120.000
#6 Oil wt:s	APC-ESP.cost.coef..	62841.000	62841.000	62841.000	62841.000
#6 Oil wt:s	Retrofit % (of BOP)	50.000	50.000	0.000	200.000

Figure A-3. Capital cost data stored in CERLDATA.CDA.

Values for file: CERLDATA.CDA (Capital Cost Data)

Tech Type		Parameter Units	Current	Default	Minimum	Maximum
#2 Oil	ft:w	Equip Cost.a (coef)	18.489	18.489	18.489	18.489
#2 Oil	ft:w	Equip Cost.b (exp).	0.846	0.846	0.846	0.846
#2 Oil	ft:w	BOP..% equip cost..	25.000	25.000	25.000	25.000
#2 Oil	ft:w	Not Used...........	0.000	0.000	0.000	0.000
#2 Oil	ft:w	APC-Baghouse coef..	26844.000	26844.000	26844.000	26844.000
#2 Oil	ft:w	APC-SO2 cost.coef..	96120.000	96120.000	96120.000	96120.000
#2 Oil	ft:w	APC-ESP.cost.coef..	62841.000	62841.000	62841.000	62841.000
#2 Oil	ft:w	Retrofit % (of BOP)	50.000	50.000	0.000	200.000

Tech Type		Parameter Units	Current	Default	Minimum	Maximum
#2 Oil	ft:s	Equip Cost.a (coef)	35.020	35.020	35.020	35.020
#2 Oil	ft:s	Equip Cost.b (exp).	0.500	0.500	0.500	0.500
#2 Oil	ft:s	BOP..% equip cost..	25.000	25.000	25.000	25.000
#2 Oil	ft:s	Not Used...........	0.000	0.000	0.000	0.000
#2 Oil	ft:s	APC-Baghouse coef..	26844.000	26844.000	26844.000	26844.000
#2 Oil	ft:s	APC-SO2 cost.coef..	96120.000	96120.000	96120.000	96120.000
#2 Oil	ft:s	APC-ESP.cost.coef..	62841.000	62841.000	62841.000	62841.000
#2 Oil	ft:s	Retrofit % (of BOP)	50.000	50.000	0.000	200.000

Tech Type		Parameter Units	Current	Default	Minimum	Maximum
#2 Oil	wt:s	Equip Cost.a (coef)	33.330	33.330	33.330	33.330
#2 Oil	wt:s	Equip Cost.b (exp).	0.630	0.630	0.630	0.630
#2 Oil	wt:s	BOP..% equip cost..	25.000	25.000	25.000	25.000
#2 Oil	wt:s	Not Used...........	0.000	0.000	0.000	0.000
#2 Oil	wt:s	APC-Baghouse coef..	26844.000	26844.000	26844.000	26844.000
#2 Oil	wt:s	APC-SO2 cost.coef..	96120.000	96120.000	96120.000	96120.000
#2 Oil	wt:s	APC-ESP.cost.coef..	62841.000	62841.000	62841.000	62841.000
#2 Oil	wt:s	Retrofit % (of BOP)	50.000	50.000	0.000	200.000

Tech Type		Parameter Units	Current	Default	Minimum	Maximum
Nat Gas	ft:w	Equip Cost.a (coef)	35.020	35.020	35.020	35.020
Nat Gas	ft:w	Equip Cost.b (exp).	0.500	0.500	0.500	0.500
Nat Gas	ft:w	BOP..% equip cost..	25.000	25.000	25.000	25.000
Nat Gas	ft:w	Not Used...........	0.000	0.000	0.000	0.000
Nat Gas	ft:w	APC-Baghouse coef..	26844.000	26844.000	26844.000	26844.000
Nat Gas	ft:w	APC-SO2 cost.coef..	96120.000	96120.000	96120.000	96120.000
Nat Gas	ft:w	APC-ESP.cost.coef..	62841.000	62841.000	62841.000	62841.000
Nat Gas	ft:w	Retrofit % (of BOP)	50.000	50.000	0.000	200.000

Figure A-3 (cont'd).

Values for file: CERLDATA.CDA (Capital Cost Data)

Tech Type		Parameter Units	Current	Default	Minimum	Maximum
Nat Gas	ft:s	Equip Cost.a (coef)	35.020	35.020	35.020	35.020
Nat Gas	ft:s	Equip Cost.b (exp).	0.500	0.500	0.500	0.500
Nat Gas	ft:s	BOP..% equip cost..	25.000	25.000	25.000	25.000
Nat Gas	ft:s	Not Used...........	0.000	0.000	0.000	0.000
Nat Gas	ft:s	APC-Baghouse coef..	26844.000	26844.000	26844.000	26844.000
Nat Gas	ft:s	APC-SO2 cost.coef..	96120.000	96120.000	96120.000	96120.000
Nat Gas	ft:s	APC-ESP.cost.coef..	62841.000	62841.000	62841.000	62841.000
Nat Gas	ft:s	Retrofit % (of BOP)	50.000	50.000	0.000	200.000

Tech Type		Parameter Units	Current	Default	Minimum	Maximum
Nat Gas	wt:s	Equip Cost.a (coef)	33.330	33.330	33.330	33.330
Nat Gas	wt:s	Equip Cost.b (exp).	0.630	0.630	0.630	0.630
Nat Gas	wt:s	BOP..% equip cost..	25.000	25.000	25.000	25.000
Nat Gas	wt:s	Not Used...........	0.000	0.000	0.000	0.000
Nat Gas	wt:s	APC-Baghouse coef..	26844.000	26844.000	26844.000	26844.000
Nat Gas	wt:s	APC-SO2 cost.coef..	96120.000	96120.000	96120.000	96120.000
Nat Gas	wt:s	APC-ESP.cost.coef..	62841.000	62841.000	62841.000	62841.000
Nat Gas	wt:s	Retrofit % (of BOP)	50.000	50.000	0.000	200.000

Tech Type		Parameter Units	Current	Default	Minimum	Maximum
Wood	wt:s	Equip Cost.a (coef)	166.450	166.450	166.450	166.450
Wood	wt:s	Equip Cost.b (exp).	0.550	0.550	0.550	0.550
Wood	wt:s	BOP..% equip cost..	25.000	25.000	25.000	25.000
Wood	wt:s	Not Used...........	0.000	0.000	0.000	0.000
Wood	wt:s	APC-Baghouse coef..	26844.000	26844.000	26844.000	26844.000
Wood	wt:s	APC-SO2 cost.coef..	96120.000	96120.000	96120.000	96120.000
Wood	wt:s	APC-ESP.cost.coef..	62841.000	62841.000	62841.000	62841.000
Wood	wt:s	Retrofit % (of BOP)	75.000	75.000	0.000	200.000

Tech Type		Parameter Units	Current	Default	Minimum	Maximum
Gas/2Oil	ft:w	Equip Cost.a (coef)	18.489	18.489	18.489	18.489
Gas/2Oil	ft:w	Equip Cost.b (exp).	0.846	0.846	0.846	0.846
Gas/2Oil	ft:w	BOP..% equip cost..	25.000	25.000	25.000	25.000
Gas/2Oil	ft:w	Not Used...........	0.000	0.000	0.000	0.000
Gas/2Oil	ft:w	APC-Baghouse coef..	26844.000	26844.000	26844.000	26844.000
Gas/2Oil	ft:w	APC-SO2 cost.coef..	96120.000	96120.000	96120.000	96120.000
Gas/2Oil	ft:w	APC-ESP.cost.coef..	62841.000	62841.000	62841.000	62841.000
Gas/2Oil	ft:w	Retrofit % (of BOP)	50.000	50.000	0.000	200.000

Figure A-3 (cont'd).

Values for file: CERLDATA.CDA (Capital Cost Data)

Tech Type	Parameter Units	Current	Default	Minimum	Maximum
Gas/2Oil ft:s	Equip Cost.a (coef)	35.020	35.020	35.020	35.020
Gas/2Oil ft:s	Equip Cost.b (exp).	0.500	0.500	0.500	0.500
Gas/2Oil ft:s	BOP..% equip cost..	25.000	25.000	25.000	25.000
Gas/2Oil ft:s	Not Used...........	0.000	0.000	0.000	0.000
Gas/2Oil ft:s	APC-Baghouse coef..	26844.000	26844.000	26844.000	26844.000
Gas/2Oil ft:s	APC-SO2 cost.coef..	96120.000	96120.000	96120.000	96120.000
Gas/2Oil ft:s	APC-ESP.cost.coef..	62841.000	62841.000	62841.000	62841.000
Gas/2Oil ft:s	Retrofit % (of BOP)	50.000	50.000	0.000	200.000

Tech Type	Parameter Units	Current	Default	Minimum	Maximum
Gas/2Oil wt:s	Equip Cost.a (coef)	33.330	33.330	33.330	33.330
Gas/2Oil wt:s	Equip Cost.b (exp).	0.630	0.630	0.630	0.630
Gas/2Oil wt:s	BOP..% equip cost..	25.000	25.000	25.000	25.000
Gas/2Oil wt:s	Not Used...........	0.000	0.000	0.000	0.000
Gas/2Oil wt:s	APC-Baghouse coef..	26844.000	26844.000	26844.000	26844.000
Gas/2Oil wt:s	APC-SO2 cost.coef..	96120.000	96120.000	96120.000	96120.000
Gas/2Oil wt:s	APC-ESP.cost.coef..	62841.000	62841.000	62841.000	62841.000
Gas/2Oil wt:s	Retrofit % (of BOP)	50.000	50.000	0.000	200.000

Tech Type	Parameter Units	Current	Default	Minimum	Maximum
2Oil/Gas ft:w	Equip Cost.a (coef)	18.489	18.489	18.489	18.489
2Oil/Gas ft:w	Equip Cost.b (exp).	0.846	0.846	0.846	0.846
2Oil/Gas ft:w	BOP..% equip cost..	25.000	25.000	25.000	25.000
2Oil/Gas ft:w	Not Used...........	0.000	0.000	0.000	0.000
2Oil/Gas ft:w	APC-Baghouse coef..	26844.000	26844.000	26844.000	26844.000
2Oil/Gas ft:w	APC-SO2 cost.coef..	96120.000	96120.000	96120.000	96120.000
2Oil/Gas ft:w	APC-ESP.cost.coef..	62841.000	62841.000	62841.000	62841.000
2Oil/Gas ft:w	Retrofit % (of BOP)	50.000	50.000	0.000	200.000

Tech Type	Parameter Units	Current	Default	Minimum	Maximum
2Oil/Gas ft:s	Equip Cost.a (coef)	35.020	35.020	35.020	35.020
2Oil/Gas ft:s	Equip Cost.b (exp).	0.500	0.500	0.500	0.500
2Oil/Gas ft:s	BOP..% equip cost..	25.000	25.000	25.000	25.000
2Oil/Gas ft:s	Not Used...........	0.000	0.000	0.000	0.000
2Oil/Gas ft:s	APC-Baghouse coef..	26844.000	26844.000	26844.000	26844.000
2Oil/Gas ft:s	APC-SO2 cost.coef..	96120.000	96120.000	96120.000	96120.000
2Oil/Gas ft:s	APC-ESP.cost.coef..	62841.000	62841.000	62841.000	62841.000
2Oil/Gas ft:s	Retrofit % (of BOP)	50.000	50.000	0.000	200.000

Figure A-3 (cont'd).

Values for file: CERLDATA.CDA (Capital Cost Data)

Tech Type	Parameter Units	Current	Default	Minimum	Maximum
2Oil/Gas wt:s	Equip Cost.a (coef)	33.330	33.330	33.330	33.330
2Oil/Gas wt:s	Equip Cost.b (exp).	0.630	0.630	0.630	0.630
2Oil/Gas wt:s	BOP..% equip cost..	25.000	25.000	25.000	25.000
2Oil/Gas wt:s	Not Used...........	0.000	0.000	0.000	0.000
2Oil/Gas wt:s	APC-Baghouse coef..	26844.000	26844.000	26844.000	26844.000
2Oil/Gas wt:s	APC-SO2 cost.coef..	96120.000	96120.000	96120.000	96120.000
2Oil/Gas wt:s	APC-ESP.cost.coef..	62841.000	62841.000	62841.000	62841.000
2Oil/Gas wt:s	Retrofit % (of BOP)	50.000	50.000	0.000	200.000

Tech Type	Parameter Units	Current	Default	Minimum	Maximum
Other 1 ??:?	Equip Cost.a (coef)	0.000	0.000	0.000	0.000
Other 1 ??:?	Equip Cost.b (exp).	0.000	0.000	0.000	0.000
Other 1 ??:?	BOP..% equip cost..	0.000	0.000	0.000	0.000
Other 1 ??:?	Not Used...........	0.000	0.000	0.000	0.000
Other 1 ??:?	APC-Baghouse coef..	0.000	0.000	0.000	0.000
Other 1 ??:?	APC-SO2 cost.coef..	0.000	0.000	0.000	0.000
Other 1 ??:?	APC-ESP.cost.coef..	0.000	0.000	0.000	0.000
Other 1 ??:?	Retrofit % (of BOP)	0.000	0.000	0.000	0.000

Tech Type	Parameter Units	Current	Default	Minimum	Maximum
Other 2 ??:?	Equip Cost.a (coef)	0.000	0.000	0.000	0.000
Other 2 ??:?	Equip Cost.b (exp).	0.000	0.000	0.000	0.000
Other 2 ??:?	BOP..% equip cost..	0.000	0.000	0.000	0.000
Other 2 ??:?	Not Used...........	0.000	0.000	0.000	0.000
Other 2 ??:?	APC-Baghouse coef..	0.000	0.000	0.000	0.000
Other 2 ??:?	APC-SO2 cost.coef..	0.000	0.000	0.000	0.000
Other 2 ??:?	APC-ESP.cost.coef..	0.000	0.000	0.000	0.000
Other 2 ??:?	Retrofit % (of BOP)	0.000	0.000	0.000	0.000

Tech Type	Parameter Units	Current	Default	Minimum	Maximum
Other 3 ??:?	Equip Cost.a (coef)	0.000	0.000	0.000	0.000
Other 3 ??:?	Equip Cost.b (exp).	0.000	0.000	0.000	0.000
Other 3 ??:?	BOP..% equip cost..	0.000	0.000	0.000	0.000
Other 3 ??:?	Not Used...........	0.000	0.000	0.000	0.000
Other 3 ??:?	APC-Baghouse coef..	0.000	0.000	0.000	0.000
Other 3 ??:?	APC-SO2 cost.coef..	0.000	0.000	0.000	0.000
Other 3 ??:?	APC-ESP.cost.coef..	0.000	0.000	0.000	0.000
Other 3 ??:?	Retrofit % (of BOP)	0.000	0.000	0.000	0.000

Figure A-3 (cont'd).

Values for file: CERLDATA.CDA (O&M Cost Data)

O & M Cost Units	Parameter	Current	Default	Minimum	Maximum
Not Used...........	Unit Cost	0.00	0.00	0.00	0.00
	RR of Esca	0.00	0.00	0.00	0.00
Water Treat.$/1000 g	Unit Cost	3.00	3.00	0.00	5.00
	RR of Esca	3.00	3.00	0.00	10.00
Oper -Labor.$/manhr.	Unit Cost	18.51	18.51	15.00	25.00
	RR of Esca	3.00	3.00	0.00	10.00
Super-Labor.$/manhr.	Unit Cost	24.38	24.38	20.00	40.00
	RR of Esca	3.00	3.00	0.00	10.00
Fuel: #2Oil..$/gal..	Unit Cost	0.61	0.61	0.25	5.00
	RR of Esca	3.00	3.00	0.00	10.00
Fuel: #6Oil..$/gal..	Unit Cost	0.43	0.43	0.25	5.00
	RR of Esca	3.00	3.00	0.00	10.00
Fuel: NatG..$/kscf..	Unit Cost	2.50	2.50	0.50	10.00
	RR of Esca	3.00	3.00	0.00	10.00
Fuel: Coal..$/ton...	Unit Cost	50.00	50.00	35.00	125.00
	RR of Esca	3.00	3.00	0.00	10.00
Fuel: Wood..$/ton...	Unit Cost	28.00	28.00	15.00	45.00
	RR of Esca	3.00	3.00	0.00	10.00
Fuel: Opt 1.$/gal...	Unit Cost	0.38	0.38	0.25	5.00
	RR of Esca	3.00	3.00	0.00	10.00
Purch Elec..$/kWh...	Unit Cost	0.08	0.08	0.01	0.20
	RR of Esca	3.00	3.00	0.00	10.00
Waste Disp..$/ton...	Unit Cost	10.00	10.00	0.00	50.00
	RR of Esca	3.00	3.00	0.00	10.00
Lime (Dry)..$/ton...	Unit Cost	60.00	60.00	25.00	200.00
	RR of Esca	3.00	3.00	0.00	10.00
Baghouse fixed exp..	Unit Cost	0.70	0.70	0.70	0.70
Baghouse fixed coef.	Unit Cost	4476.00	4476.00	4476.00	4476.00
Baghouse varia coef.	Unit Cost	0.34	0.34	0.34	0.34
ESP fixed exp.......	Unit Cost	0.70	0.70	0.70	0.70
ESP fixed coef......	Unit Cost	4476.00	4476.00	4476.00	4476.00
ESP varia coef......	Unit Cost	0.17	0.17	0.17	0.17
Dry Scrub fixed exp.	Unit Cost	0.70	0.70	0.70	0.70
Dry Scrub fixed coef	Unit Cost	6715.00	6715.00	6715.00	6715.00
Dry Scrub varia coef	Unit Cost	0.68	0.68	0.68	0.68

Figure A-4. O&M cost data stored in CERLDATA.CDA.

Values for file: CERLDATA.CDA (Misc Param Data)

Parameter Units	Current	Default	Minimum	Maximum
Not Used...............	0.00	0.00	0.00	0.00
Engr,Des,Const Mgmt...%	25.00	25.00	0.00	40.00
Cap Cost Contingency..%	15.00	15.00	0.00	5[illegible].00
Not Used...............	0.00	0.00	0.00	0.00
Taxes and Insurance...%	0.00	0.00	0.00	10.00
Yr of annual cost data.	1990.00	1990.00	1980.00	2020.00
Inflation ....%	3.00	3.00	0.00	50.00
Turn Down Ratio : Coal	3.00	3.00	1.00	10.00
Turn Down Ratio : Oil	4.00	4.00	1.00	10.00
Turn Down Ratio : Gas	5.00	5.00	1.00	10.00
Turn Down Ratio : Wood	3.00	3.00	1.00	10.00
Stoichiometric Ratio...	2.00	2.00	1.00	3.00

Figure A-5. Miscellaneous parameters data stored in CERLDATA.CDA.

Values for file: CERLDATA.CDA (Capital Cost Indices)

Reference year = 1987 Cost index for this year = 323.80

Year	Current Index	Calculated Rate %
1987	323.80	N/A
1988	342.52	5.78
1989	355.43	3.77
1990	366.09	3.00
1991	377.07	3.00
1992	388.39	3.00
1993	400.04	3.00
1994	412.04	3.00
1995	424.40	3.00
1996	437.13	3.00
1997	450.25	3.00
1998	463.75	3.00
1999	477.67	3.00
2000	492.00	3.00
2001	506.76	3.00
2002	521.96	3.00
2003	537.62	3.00
2004	553.75	3.00
2005	570.36	3.00
2006	587.47	3.00

Figure A-6. Capital cost indices stored in CERLDATA.CDA.

Values for file: CERLDATA.CDA (O&M Cost Indices)

Reference year = 1987 Cost index for this year = 813.60

Year	Current Index	Calculated Rate %
1987	813.60	N/A
1988	852.00	4.72
1989	895.11	5.06
1990	921.97	3.00
1991	949.63	3.00
1992	978.11	3.00
1993	1007.46	3.00
1994	1037.68	3.00
1995	1068.81	3.00
1996	1100.88	3.00
1997	1133.90	3.00
1998	1167.92	3.00
1999	1202.96	3.00
2000	1239.05	3.00
2001	1276.22	3.00
2002	1314.50	3.00
2003	1353.94	3.00
2004	1394.56	3.00
2005	1436.39	3.00
2006	1479.49	3.00

Figure A-7. O&M cost indices stored in CERLDATA.CDA.

APPENDIX B: Descriptions and Sources for CERLDATA.CDA

The following lists describe and reference select portions of the data contained in CERLDATA.CDA.

Fuel Data:

1. Fuel Type 1 is 33 degree API, low sulfur No 2 Oil.
2. Fuel Type 2 is 12.6 degree API, low sulfur No 6 Oil.
3. Fuel Type 4 is high-volatile A bituminous coal.
4. Fuel Type 5 is nonresinous, seasoned wood.
5. Fuel Type 6 is 15.5 degree API, high sulfur No 6 Oil.

Capital Costs:

1. Equipment Cost Coefficients were furnished by Arthur D. Little, Inc.
2. Equipment Cost Exponents were furnished by Arthur D. Little, Inc.
3. APC-Baghouse Cost Coefficients were furnished by Arthur D. Little, Inc.
4. APC-SO2 Cost Coefficients were furnished by Arthur D. Little, Inc.
5. APC-ESP Cost Coefficients were furnished by Arthur D. Little, Inc.

O&M Cost Data:

1. Operational labor cost is based on the 1990 wage rate (including all overheads) for a U.S. Government Technician, GS Level 10, Step 1.
2. Supervisory labor cost is based on the 1990 wage rate (including all overheads) for a U.S. Government Technician, GS Level 12, Step 1.
3. The Baghouse Fixed Exponent was furnished by Arthur D. Little, Inc.
4. The Baghouse Fixed Coefficient was furnished by Arthur D. Little, Inc.

5. The Baghouse Variable Coefficient was furnished by Arthur D. Little, Inc.

6. The ESP Fixed Exponent was furnished by Arthur D. Little, Inc.

7. The ESP Fixed Coefficient was furnished by Arthur D. Little, Inc.

8. The ESP Variable Coefficient was furnished by Arthur D. Little, Inc.

9. The Dry Scrubber Fixed Exponent was furnished by Arthur D. Little, Inc.

10. The Dry Scrubber Fixed Coefficient was furnished by Arthur D. Little, Inc.

11. The Dry Scrubber Variable Coefficient was furnished by Arthur D. Little, Inc.

Capital Cost Indices:

The annual indices used to escalate capital costs are obtained from *Chemical Engineering Magazine's* CE PLANT COST INDEX.

O & M Cost Indices:

The annual indices used to escalate operations and maintenance costs are obtained from *Chemical Engineering Magazine's* MARSHALL & SWIFT EQUIPMENT COST INDEX.

APPENDIX C: Plant Location Names

AK	Alaska	MT	Montana
AL	Alabama	NE	Nebraska
AZ	Arizona	NV	Nevada
AR	Arkansas	NH	New Hampshire
CA	California	NJ	New Jersey
CO	Colorado	NM	New Mexico
CT	Connecticut	NY	New York
DE	Delaware	NC	North Carolina
FL	Florida	ND	North Dakota
GA	Georgia	OH	Ohio
HI	Hawaii	OK	Oklahoma
ID	Idaho	OR	Oregon
IL	Illinois	PA	Pennsylvania
IN	Indiana	RI	Rhode Island
IA	Iowa	SC	South Carolina
KS	Kansas	SD	South Dakota
KY	Kentucky	TN	Tennessee
LA	Louisana	TX	Texas
ME	Maine	UT	Utah
MD	Maryland	VT	Vermont
MA	Massachusetts	VA	Virginia
MI	Michigan	WA	Washington
MN	Minnesota	WV	West Virginia
MS	Mississippi	WI	Wisconsin
MO	Missouri	WY	Wyoming

DC District of Columbia (Washington D.C.)

All other locations are classified as OCONUS (outside the continental United States).

GLOSSARY

ABD: Analysis base date.

Absolute Pressure: Pressure measured with respect to a vacuum (zero pressure); the sum of the gauge and atmospheric pressures.

AED: Analysis end date.

AFM: Air Force manual.

Analysis: Qualitative or quantitative statement of findings.

APC: Air pollution control.

Array: A sequential group of data elements of the same type that are arranged in a single data structure and are accessible by an index.

ASCII Character Set: The standard set of numbers representing the characters and control signals used by computers, as defined by the American Standard Code for Information Interchange.

As-Fired Fuel: The condition of a fuel when it is fed to the fuel burning equipment.

Ash: The incombustible material in fuel.

Availability Factor: The fraction of the time during which a unit is in operable condition.

Bag: The customary form of filter element. Also known as tube, stocking, etc., a bag can be unsupported (dust on inside) or used on the outside of a grid support (dust on the outside).

Bag Filter: A device containing one or more cloth bags for recovering particles from the dust laden gas or air which is blown through.

Baghouse: An air pollution abatement device used to trap particulates by filtering gas streams through large fabric bags usually made of glass fibers.

Base Load: Base load is the term applied to that portion of a station or boiler load that is practically constant for long periods.

Blowdown: Removal of a portion of boiler water for the purpose of reducing solids concentration, or to discharge sludge.

BOD: Beneficial occupancy date.

Boiler Efficiency: The ratio of usable boiler output to input as defined by the ASME Power Test Code. This value for efficiency includes boiler blowdown as well as the performance of the deaerator and the feedwater heater.

Boiler Horsepower: The evaporation of 34.5 lbs (15.648 kg) of water per hour from a temperature of 212 deg F (100 deg C) into dry saturated steam at the same temperature. Equivalent to 33,472 Btu/hr (35,291,203 joule).

Boiler Water: A term used to define a representative sample of the water circulating through a boiler. The sample is obtained after the generated steam is separated and before any incoming feedwater or chemical treatments are added.

BOP: Balance of plant.

British Thermal Unit (Btu): One Btu is the quantity of energy required to raise the temperature of one pound of water by one degree Fahrenheit (approximately 252 calories).

Btu: British thermal unit.

CE: Capital Equipment.

Cf: Cubic feet.

Coal: Solid hydrocarbon fuel formed by ancient decomposition of woody substances under conditions of heat and pressure.

Coal-sto: Coal fed by a stoker.

Combustible: The heat producing constituents of a fuel.

Combustion: Combustion is a rapid chemical reaction which generates heat. Heat energy is liberated when oxygen combines with the combustible elements of a fuel.

Combustion Rate: The quantity of fuel fired per unit time.

Compiler: A computer program that translates a program written in a high-level language into machine language.

Condensate: Liquid water resulting from the removal of latent heat from steam.

Condensate Returned: The percentage of liquid water that is returned through a steam distribution system.

Constant: A fixed value.

Continuous Blowdown: The continuous removal of boiler water to reduce the concentration of solids, or to discharge sludge.

Cursor: The character on a computer screen which indicates the current text entry position to the user.

Deg F: Degrees Fahrenheit.

Design Load: The load for which a steam generating unit is designed. Design load is typically the maximum load to be carried.

Design Pressure: The maximum allowable working pressure permitted under the rules of the ASME Construction Code.

Directory: A specifically named work area on a computer disk.

Distillate Oil: Number 2 Oil.

DM: Deutsche marks.

Dry Bulb Temperature: The temperature of dry air.

Dry Scrubber: A flue gas desulfurization system in which sulfur dioxide is collected by a solid medium. The final product is typically a fine, dry powder.

EDC: Engineering, design, and construction.

Efficiency: The ratio of output to input. The efficiency of a steam generating unit is the ratio of the heat absorbed by the water and/or steam to the heat released from the firing of the fuel.

Electrostatic Precipitator (ESP): A device for collecting particulate matter from a gas stream using an electrostatic charge.

Enthalphy: A thermal property of a fluid, equivalent to the internal energy plus the product of the pressure and the volume.

ESP: Electrostatic precipitator.

Execute: To start a computer program.

Extension: An optional three-character ending for a standard DOS file name.

Feedwater: Water introduced into a boiler including make-up water and returned condensate.

File: A user-named set of data stored on a computer disk.

Fire-Tube: A boiler tube which carries the products of combustion through the boiler water.

FLED: Facility life end date.

Floppy Disk: A flexible plastic disk coated with magnetic material used to store computer data. Floppy disks are usually found in 5.25 in. and 3.5 in. sizes.

Flow Chart: A graphical representation of the definition, analysis, or method of solution of a problem.

Flue Gas: The gaseous products of combustion.

Fly Ash: The fine particles of ash which are carried by the products of combustion.

Ft:s: Fire-tube furnace that produces steam.

Ft:w: Fire-tube furnace that produces hot water.

Furnace: An enclosed space which facilitates the combustion of fuel.

Gal: Gallon.

Gauge Pressure: The pressure above atmospheric pressure.

Hard Copy: A printed copy of a computer generated output.

Hard Drive: A nonremovable magnetic disk used to store computer data.

HDD: Heating degree days.

Heating Degree Day: Each degree of declination below 65 deg F in mean outdoor temperature, averaged over a 24-hour period, is a degree day.

HHV: Higher heating value.

Higher Heating Value: The total energy released from the combustion of a specified quantity of fuel.

HPECON: Heating Plant Options Economic Analysis System.

Hr: Hour.

Initialize: The process of giving a known initial value to a variable or data structure.

Input: Information which a computer program receives from an external device, such as a keyboard or a disk drive.

Integer: A member of the set of positive whole numbers (1,2,3,...), negative whole numbers (-1,-2,-3,...), and zero (0).

IR: Interim report.

Kscf: One thousand standard cubic feet.

KWh: Kilowatt-hour.

LCC: Life cycle cost.

LCCID: Life Cycle Cost in Design.

Loop: A set of statements that are executed repeatedly.

Lb: Pounds force.

Lbm: Pounds mass.

Make-Up: Water added to the boiler to compensate for water lost through exhaust, blowdown, leakage, etc.

MBtu: One million British thermal units.

Mechanical Stoker: A device which automatically feeds solid fuel into a furnace, distributes it over a grate, injects air for combustion, and then removes the combustion refuse.

Memory: The space within a computer for holding information and running programs.

Monitor: A high-speed device, similar to a television picture tube, which provides a visual, nonpermanent display of system input/output data.

MPC: Midpoint of construction.

NAVFAC: Naval Facilities.

Net PW: Net present worth.

No-Load Load: The load associated with a steam or hot water distribution system (e.g., thermal and leak losses). These losses are assumed to be constant.

OCONUS: Outside of the Continental United States.

O&M: Operations and Maintenance.

Operating System: A program that manages all operations and resources of the computer.

Output: The information generated by running a program. Output can be sent to a printer, displayed on a monitor, or written to a disk.

Overfeed Stoker: A mechanical stoker which feeds fuel onto grates located above the point of air injection.

Packaged Steam Generator: A boiler equipped and shipped complete with fuel burning equipment, mechanical draft equipment, automatic controls and accessories. Usually shipped in one or more major sections.

Parasitic Load: The constant load on a system due to secondary demands such as domestic hot water.

Parasitic Power: The power load due to auxiliary components other than those defined under **Boiler Efficiency**. All of these auxiliary components are assumed to be electrically driven (e.g., pumps and fans).

Particulates: Fine liquid or solid particles such as dust, smoke, mist, or fumes, found in the input air or the boiler emissions.

Peak Load: The maximum load carried for a stated short period of time.

Printer: An output device connected to a computer for generating hard copies.

Process Load: The load due to some type of manufacturing process. This load is assumed to be constant.

Process Steam: Steam used for industrial purposes other than for producing power or for space heating.

Program: A set of coded instructions that direct a computer to perform a specific function.

Proximate Analysis: Analysis of a solid fuel determining moisture, volatile matter, fixed carbon, and ash expressed as percentages of the total weight of the sample.

Psig: Pounds per square inch gauge.

PW: Present worth.

Random-Access Memory (RAM): Computer memory which can read and store data.

Rate Of Blowdown: A rate normally expressed as a percentage of the incoming water.

Rated Capacity: The maximum output for a piece of machinery as stated by the manufacturer.

Residual Oil: Number 6 oil.

Retrofit: A retrofit project assumes the use of the existing plant structure as well as all workable auxiliary equipment.

RR of Esca: Real rate of escalation.

Saturated Steam: Water vapor at the saturation temperature.

Saturation Pressure: The pressure at which vaporization takes place for a given temperature.

Saturation Temperature: The temperature at which vaporization takes place for a given pressure.

Save: To store information on a floppy or hard computer disk.

Scalar: A dimensionless real number.

SCF: See Standard Cubic Foot.

Screen: See Monitor.

Software: Coded instructions that direct the operation of a computer.

Standard Cubic Foot: A volume measurement equal to the volume of a cube with edges 1 ft long.

Standard Volume: The volume of a gas at standard temperature and pressure. In the United States, this volume is normally expressed in standard cubic feet.

Stoichiometric Ratio: A measure of the relative quantities of reactants and products in a chemical reaction.

Stoker: See Mechanical Stoker.

Sq Ft: Square foot.

Time Value of Money: If project cash flows are stated in constant dollars, their adjustment to a common time basis is necessary to take into account the real earning potential of investments over time.

TM: Training manual.

Ton: 2000 pounds.

TR: Technical report.

Ultimate Analysis: Chemical analysis of a solid, liquid or gaseous fuel. In the case of coal, determination of carbon, hydrogen, sulfur, nitrogen, oxygen, and ash.

Underfeed Stoker: A mechanical stoker which feeds fuel onto grates located below the point of air injection.

USACERL: U.S. Army Construction Engineering Research Laboratory.

USACERL-ES: U.S. Army Construction Engineering Research Laboratory - Energy and Utility Systems Division.

Water-Tube: A boiler tube which carries the water through the combustion chamber.

Wt:s: Water-tube furnace that produces steam.

Yr: Year.

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